OSTEOMYELITIS AND COMPOUND FRACTURES

H. WINNETT ORR, M.D., F.A.C.S.

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AND

OTHER INFECTED WOUNDS

TREATMENT BY THE METHOD OF
DRAINAGE AND REST

BY

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ILLUSTRATED

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IT IS a particular pleasure to dedicate this small volume to Dr. John Ridlon. To him more than to any other surgeon the author is indebted for the inspiration and the information upon which this work is based. Dr. Ridlon has always been helpful to younger men in the profession. His precepts have been sound and his example excellent. Always conscientious in his dealings with patients, there are many of them, who, with orthopedic surgeons everywhere, will continue to remember him (as the author does) with feelings of gratitude and affection.

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PREFACE

In the pages following, the attempt has been made to lay the foundation for, and to describe, my method for the treatment of infected wounds, especially of bones and joints. In a considerable number of discussions of a less formal character, I have found that questions regarding the method to be described have tended to take a personal turn, especially as to the manner in which my investigations were carried on and as to the influences that led to my conclusions. At the risk of some informality, then, I shall set down in the preface a short account of the early experiences and influences that have had an important bearing upon this work.

My earliest professional training was largely in the laboratory. For a number of years zoology, comparative anatomy, histology, and pathology were my principal studies. Later, in general practice, I found myself at all times inclined to consider the condition of the patient's tissues a matter of great importance in his treatment. For that reason, even as a general practitioner, my leanings were towards surgery and surgical problems.

After five years of general practice, it was my good fortune to come under the influence in Chicago, of Dr. John Ridlon, who undertook to launch me upon the practice of orthopedic surgery. Dr. Ridlon's ideals and ideas are all too well known to require extensive comment. I may mention, however, that Dr. Ridlon impressed me very early with the importance of adequate physical and physiologic rest for inflamed parts. Dr. Ridlon was one of the earliest and most enthusiastic advocates of the employment of both the Thomas splint and the plaster of Paris cast for joint infections and similar lesions. In fact, as a crusader for the principles of Hugh Owen Thomas, Dr. Ridlon precipitated in New York some of the difficulties that, among other things led him to transfer his professional activities

from New York to Chicago. The successful application of adequate splints, especially plaster of Paris, has always been an important part of Dr. Ridlon's teaching. From the beginning of my own orthopedic practice, therefore, immobilization as taught by Thomas and Ridlon has been one of the fundamentals of treatment.

Many years ago one of the things in the results of orthopedic surgical procedure that impressed me was that, having placed an ankle, hip, or knee in a cast after an open operation of any kind, it was frequently discovered upon changing the cast four or six weeks later that there had been, in the meantime, a mild postoperative infection which had healed under the cast. Such complications sometimes occurred with no symptoms whatever, although in some cases it had been noted on the patient's chart that there were a few days with a slight rise of temperature. At rare intervals there were cases in which the postoperative local conditions were sufficient to call for investigation inside the cast, or its removal. I remember that in about the year 1912 I made the remark to one of the Chicago surgeons that Dr. Lord and I had done operations every week for two years at the Nebraska Orthopedic Hospital without having had any postoperative infectious complications of importance. In the discussion which followed I suggested that the employment of plaster casts, even after hernia operations on children, was a factor of importance in obtaining such results.

At the time of various innovations in wound treatment, especially of bones and joints, we tried out the Beck bismuth paste, Mosetig-Moorhof plugs, and the Bipp method, all with some good results, but not with enough uniformity to give us confidence in an extensive application of the method. We had, of course, always employed, antiseptics of all kinds for all kinds of wounds, as we had been taught to do; and the question regarding the propriety of antiseptic wound treatment, as it was then carried out, did not arise until after my investigations, which followed our experience during the Great War.

When the war came on, the situation that I found when I arrived in Great Britain for military duty made a very strong impression. All forms of treatment were being subordinated to the irrigations, flushings, and packs with all the kinds of chemicals, old and new, that were being tried out in the hope of solving the problem of the infected wound. The orthopedic principles taught by Thomas, Ridlon, and others, were being set aside, even despite the efforts of Sir Robert Jones and others to secure adequate splinting and protection of these injured parts. The fact of the matter was that splinting and wound treatment could not be reconciled, and wound treatment was considered the more important of the two. After months of experience with this sort of thing, I finally came to the conclusion myself that the wrong alternative had been chosen; that as between antiseptic wound treatment as commonly employed and adequate splinting, which was not being employed, good splinting could be depended upon to give better results, even if wound treatment were made secondary.

When I was transferred from Great Britain to France the opportunity came to make extensive use of plaster of Paris in compound fractures and other infected wound cases. It soon became evident that patients in plaster did better, even with less wound treatment, than those who were given wound treatment but inadequately immobilized in splints.

Upon returning to the United States I was astonished to find that splinting, on the whole, was in much the same state that it had been in Great Britain and France two or three years before. Many of the casts and splints well applied to patients for transfer from France to the United States were promptly removed upon arrival in this country. Not only so, but these devices were left off entirely or, in many cases, less efficient apparatus was substituted.

My return to civil practice was, from that standpoint, equally disappointing. So far as one could observe, sur-

gery had learned nothing from the military experience. Special literature a little later began to contain articles citing the lessons of the war. From the orthopedic standpoint these added insult to injury. We were told, even by some of those who had been most active in military circles, that we had learned during our military experience that the splinting of fractures was less important than we had formerly believed; that early mobilization of compound fractures, even those involving joints, was to be employed in the effort to maintain motion in such joints, and finally—this was taught in many important communications—that the outstanding lesson of the war was the em ployment of the Carrel technic with Dakin solution for the cleaning up of contaminated and infected wounds.

I had already concluded that the Carrel-Dakin technic, incompatible as it is with the orthopedic treatment of fractures, joint injuries, and even of extensive soft part wounds, was less important than adequate immobilization in correct position. At that time, therefore, I decided upon an advocacy of protection and rest, as opposed to irrigation and motion. In order to fortify my position I went back to the writings of John Hunter, Hilton, Lister, and Hugh Owen Thomas, some of which I had not read for a number of years. I was much gratified to find, as I did find, more and more support not only for the position at which I had arrived, but for an even more radical position than I had so far been able to take. My research in medical literature has thus led me to a further change in attitude toward these problems. Additional study of the writings of many previous investigators combined with extensive clinical experiences of my own and others has completely convinced me of the validity of my position and of my conclusions regarding treatment.

The thesis of this book, arising from the training and the experiences which I have described, may be summarized very briefly as follows: (1) the use of antiseptics in the treatment of infected wounds has been developed to the

point of abuse; (2) it seems that it is not generally known that infected wounds do heal without the application of antiseptic agents of any kind; (3) wounds, if properly protected, will heal consistently without daily dressings or irrigation with antiseptics in a way that is at once easier and better; and (4) the important factors in securing these better results are (a) primary asepsis or antisepsis when required, (b) adequate drainage, (c) immobilization of injured parts, and (d) protection of wounds against disturbance and reinfection. In a word, it is the method of drainage and rest. It will appear moreover that this technic is not only superior when the infected wound itself is considered, but also when the orthopedic principles involved in the treatment of osteomyelitis and compound fractures are taken into account.

The earlier chapters of this book will indicate the misuse of antiseptics arising from our neglect of the original teachings of Lister. The period of the world war brings this misuse into still sharper relief. The lessons of the war, if they had been learned instead of forgotten, might have changed our outlook; most of the present-day treatment of compound fractures and osteomyelitis, however, indicates that most of the profession has not learned its lesson, that the task is still to be done. The principles and technic of treatment outlined in the latter chapters of this book may claim to rest on the surgical precepts of Hunter, Hilton, Lister, and others and to take account of the lessons arising from the surgical results—or lack of them—in the last war.

The material which I have used, both that drawn from my own experience and that taken from surgical literature, has been rather slowly gathered. This statement is made only after about seven years of study and research. To those who have objected to my method on the grounds that it lacks scientific foundation, I can only reply that a careful study of the material should reveal the fact of a science in practice and in literary research as well as a science of

the laboratory. Scientific rules are in part, at least, empirically derived; and in science, there may very well be as much truth in a method pragmatically arrived at, as in one established more or less a priori in the laboratory.

I am greatly indebted to my immediate associates and to the sound orthopedic surgeons whose results I have been able to make use of in this book. In particular, it gives me great pleasure to acknowledge my indebtedness to my associate Dr. J. E. M. Thomson, and my assistant, Miss Gertrude Krausnick, for their interest and assistance in the clinical work; Dr. F. J. Gaenslen, of Milwaukee, Wisconsin, Dr. Arthur Steindler, of Iowa City, Iowa and Dr. Ellis Jones, of Los Angeles, who have been especially helpful on account of their early and complete adoption of the method advocated here and who have been extremely successful in securing results that contribute to the support of our contentions.

Dr. Steindler and Dr. Philip Lewin, of Chicago, very kindly assisted in the arrangement of some parts of the manuscript in its early stages. Acknowledgement has already been made of the great debt the author owes to Dr. Ridlon. To the Drs. Mayo and Dr. M. S. Henderson, of Rochester, Minnesota, I am particularly indebted for the opportunity to address the Staff of the Mayo Clinic and Fellows of the Mayo Foundation in May, 1927. The publication of the address delivered upon this occasion in *Surgery, Gynecology, and Obstetrics* in October, 1927, undoubtedly contributed more than anything else to a prompt and widespread recognition of the method.

Last, but not least, I desire to acknowledge my debt to my son, Douglass Winnett Orr, for much painstaking work in the construction and arrangement of the manuscript in its final stages for transmission to the publishers. To the publishers, The C. V. Mosby Company, I desire to express my appreciation of their uniform interest and courtesy in the publication of the book.

Lincoln, Nebraska.

H. Winnett Orr.

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INTRODUCTION

Doctor Orr came to me twenty-four years ago for advice and encouragement, wishing to specialize in orthopedic surgery. He was young; I was at my best. Now I am old, and he is at his best. It gives me great pleasure to say a word of introduction to his book.

It has been said that among business men not more than two of each hundred become eminently successful. Looking back over the more than fifty years that I have been in practice and considering the accomplishments of the very large number of physicians and surgeons that I have known, the same rule holds good. But the number that have accomplished one new and *good* thing is still less; I mean that have made a real advance that will last not only during their lives, but long after they are dead. I believe that Dr. Orr has done just that. This is high praise.

During a lifetime spent in the treatment of bone and joint diseases I have had not a few cases of osteomyelitis. Up to the time of the Great War I believed in free drainage of acute myelitis, and then no surgery until the dead bone had become separated from the living bone, when it should be gently removed.

On Chutro's return from France I was "sold" to his method. In practice, however, I found it difficult to follow strictly and successfully, and I think other surgeons have had a like experience. As with the Carrel-Dakin method, only an occasional surgeon could and would see to it that the treatment was carried through to a successful issue. Despite this neglect many wounds healed, and were credited to the method instead of to the Grace of God. The essence of the Carrel-Dakin treatment was that the wound could and should be chemically sterilized until a definite bacterial count was obtained, when the wound could be closed. If it remained closed, and healed, and remained healed, the result was credited to the method. But if it

did not—and in not a few cases it did not—then the failure was credited to some overlooked pocket of infection. If I had an infected wound, I would be pleased to have it treated by Dr. Carrel by his method; but not by Dr. Orr by that method. If I had an osteomyelitis, I would gladly have Dr. Chutro treat it by his method; but if I were in the hands of any other surgeon, I would choose to have it treated by Dr. Orr's method.

To teach a method that only the most skillful and the most careful surgeons can and will carry out carefully and completely is of little use to humanity. It is more often harmful than beneficial. Dr. Orr's method can be carried out by even a clumsy surgeon and a lazy one. It has been done by many with as good results as have been obtained by Dr. Orr himself. Here, then, we have a method that can be safely taught for use by the rank and file of the profession. Any one who can operate by any method on a case of osteomyelitis can do Dr. Orr's operation—if he will. That many general surgeons will fail to carry out Dr. Orr's method completely I believe, for few general surgeons have any appreciation of the value of rest, and few can put on a passable plaster cast. As the general surgeon thinks that a tuberculous abscess—one not yet open—contains "pus," and therefore must be opened; so he thinks that a foul-smelling dressing must be removed and made to smell of something else. One is not necessarily more true than the other. The tuberculous abscess should not be opened—unless it is doing the patient harm. It is usually doing him good. So the foul-smelling dressing covering the operative wound of an osteomyelitis should not be removed, unless it is doing the patient harm. Most general surgeons have patience to wait only *between* operations; not for the patient to get well. They lack the orthopedic instinct. The general surgeon expects a simple fracture to become united in from four to six weeks; after that it is an ununited fracture. The orthopedic surgeon knows it may be four or six months, even eighteen months, before it can justifiably be called an ununited fracture and he be war-

ranted in making it a compound fracture by an operation. Therefore, to those surgeons who may read this Introduction, I wish to say, as Dr. Robert Weir once said to me in the days of my mettlesome youth: "Remember what Talleyrand said, 'Be zealous; but don't be too damned zealous.'"

Again, remember the teaching of Alonzo Clark, that pre-eminent teacher of medicine of the last century: "Don't treat your patients too much. Let them get well if they can."

Do an operation that will insure free drainage, drainage without rubber tubes, or gauze wicks, or other drains. Make a wound that will drain of itself. Cover the raw surface of bone and flesh with a smooth and unirritating dressing, with enough pressure to insure healthy granulations. Rest the entire wound by a plaster cast that will immobilize the joint below and the joint above the wound. Then observe the patient—not the wound alone.

For forty years I have immobilized all my operative wounds, of soft parts as well as of bones, with plaster casts; and then watched the patient—not the wound. How little the importance of rest is understood was well illustrated by recent experience. A grandchild suffered an extensive burn of the leg from boiling water. I asked the operating-room nurse at the hospital to put up for me the necessary dressings, specifying what I wanted. These things included plaster bandages. When I opened the package to dress the burn, *there were no plaster bandages.* This efficient nurse, trained mainly by general surgeons, could not believe it possible that one should use a plaster splint in the treatment of a burn.

As the layman fears blood, so the average doctor fears a wound—and forgets the patient.

As the Thomas hip splint was so simple that few could be brought to use it intelligently, so the Orr method of treating osteomyelitis is so simple that it is difficult to convince surgeons that "That is all there is to it."

Newport, R. I. JOHN RIDLON.

OSTEOMYELITIS
AND
COMPOUND FRACTURES

CHAPTER I

Sir Joseph Lister and Antisepsis

Most of us know and pay tribute to the epoch-making contribution of Lord Lister in applying Pasteur's "germ theory" of putrefaction to surgery. Most of us do not know, however, that much of what passes for Listerism today violates many of the cardinal principles of his teaching, and dishonors his name in taking it. Listerism rightly so-called versus Listerism wrongly so-called; that is our present concern.

It would be out of place here to trace the whole story of Lister's achievement, but its importance may be suggested. To him we are indebted in great measure for the entire modern system of clean or aseptic surgery. Lister was the first to work out the surgical method now in common use under the title of the "antiseptic system." In his honor aseptic (no infection) and antiseptic (anti-infection) surgical technic have commonly been referred to as Listerism.

Listerism, with a few improvements, has conferred enormous benefits upon all those who have suffered injuries or diseases requiring surgical treatment. It is almost impossible for us at the present time to realize how great a difference there is between the hospital conditions and the hospital methods of today and those of fifty years ago.

About 1860, Lister was engaged upon a study of the causes of infection and inflammation in wounds: he referred to the condition as "putrefaction" in wounds because in practically all cases of infected wounds there were disagreeable decomposition and unpleasant odors as well as other dangerous features. Operations in all cases at that time carried with them not only the danger of the operation itself, but the danger of secondary infection, putrefaction, hemorrhage, gangrene, erysipelas, hospital fever, and the like. The causes of these conditions were not understood. Lister, himself, in the early years of his practice, treated such conditions on the theory that they were caused by the entrance of air or oxygen into the wounds. Pasteur, the great French chemist, was the first to show the relationship between definite living organisms and certain kinds of fermentation, putrefaction, and infection. In referring to this, Lister said:

"In the course of an extended investigation into the nature of inflammation, and the healthy and morbid conditions of the blood in relation to it, I arrived several years ago, at the conclusion that the essential cause of suppuration in wounds is decomposition brought about by the influence of the atmosphere upon blood or serum retained within them, and in the case of contused wounds, upon portions of tissue destroyed by the violence of the injury.

"To prevent the occurrence of suppuration, with all its attendant risks, was an object manifestly desirable; but until lately apparently unattainable, since it seemed hopeless to attempt to exclude oxygen, which was universally regarded as the agent by which putrefaction was effected. But when it had been shown by the researches of Pasteur that the septic property of the atmosphere depended not on the oxygen or any gaseous constituent, but on minute organisms suspended in it, which owed their energy to their vitality, it occurred to me that decomposition in the injured part might be avoided without excluding the air,

by applying as a dressing some material capable of destroying the life of the floating particles.'"[1]

Lister seized upon the work of Pasteur as the solution of the phenomena which he had been trying to explain.

Lister had already made some observations upon the influence of carbolic acid in the prevention of putrefaction; he immediately set about to determine in what cases carbolic acid might be used in connection with the prevention and control of infection in wounds. He soon found that by using carbolic acid to clean up the hands, instruments, and other materials employed in operations, and by using carbolic acid preparations of various kinds to exclude infection from the wounds during and following operation, many of these so-called hospital diseases due to infection could be prevented. The working out of this so-called antiseptic system covered a period of twenty years and involved the overcoming of many serious difficulties. In the end, however, Listerism was gloriously triumphant and is, in slightly modified form, the method of today.

Godlee, in his *Life of Lord Lister,* gives the following points as those of most importance which came to Lister out of the work of Pasteur and which contributed so much to the development of the Lister method.

"Putrefaction is a species of fermentation.

"It is caused by the growth of microorganisms and does not occur independently of their presence.

"The microorganisms that produce fermentation and putrefaction are carried by the air on the dust that floats in it. They also occur on and in solid and liquid substances.

"These microorganisms can be destroyed by heat and other agencies or separated from the air by filtration.

"Certain recognizable organisms produce definite and distinct fermentative processes.

"All of these organisms require oxygen. Some of them flourish only in the presence of free oxygen (aerobic),

[1]Lister, Sir Joseph: Collected Papers, Oxford. 2: 37, 1909.

others only in the absence (anaerobic). The latter acquire their oxygen from the bodies which, by their growth, they are causing to ferment and putrefy.

"Many natural animal and vegetable products have no tendency to ferment and putrefy, even in the presence of oxygen, if collected with proper precautions and kept in sterilized vessels.

"Spontaneous generation has never been observed to occur and thus may be regarded as a chimera."

The terrible effects of wound infection before the introduction of Listerism, or the antiseptic method, were an individual matter with every patient. Inflammation of every surgical wound, and, in fact, of every accidental wound, was expected. It was simply a question as to what form the infection would take and how severe it would be. Tetanus, erysipelas, and gangrene always threatened; and even following trivial injuries and operations they were likely to prove fatal. One writer said, "After suppuration was well established, under favorable circumstances the fever abated, the wound became less painful and less red, and, as the granulations filled up from the bottom, suppuration gradually diminished and finally stopped. The process of healing occupied weeks and months and left a scar that was sometimes wide and puckered. Surgeons were quite satisfied with such a result, and were full of self-congratulation if anything better was achieved."

Unfortunately these infections might occur not only at the time of the operation or the injury but they might be acquired like diphtheria or scarlet fever, in the hospital wards. They were known as hospital diseases, and there was no known method of sanitation or disinfection for their control. In a few instances hospitals were burned or torn down because these infections became so severe. This condition is well described by a British surgeon in an article published in 1874, before the Lister method had begun to exert an influence upon the conduct of surgical departments in hospitals:

"I am acquainted with other instances of hospital infection, nearly, if not quite, as serious as this; but, as they have not yet been brought before the public, I refrain from mentioning them. But surely no stronger or more conclusive evidence is needed of the tenacious and ineradicable nature of this pyemic infection when once it has taken firm hold of a hospital than that which is furnished by the examples just given. What name so appropriate as 'hospitalism' for a condition of things such as here described? The town free from infection, the hospital saturated by it, so as to induce its surgeons to recommend their patients not to enter it, to compel them to refrain from operating; and after every attempt that science and humanity could suggest, every hygienic means employed in vain in the fruitless attempt to eradicate the pestilence from the very fabric itself, compelling the governors as a last resource to decide on the demolition of the building and its complete reconstruction, at a vast expense as the only remedy. The truth is, it is as impossible to disinfect it by any known hygienic means as it would be to disinfect a crumbling wall of the ants that have taken possession of it, or an old cheese of the maggots which it has generated. There is in these extreme cases only one remedy left, that remedy which the Governors and Staff of the Lincoln County Hospital have so generously, so disinterestedly, so nobly, resolved on—viz., the demolition of the infected fabric and the destruction of its materials. For this last clause must not be forgotten. Just as cattle-plague has to be stamped out by the pole-axe, so has the infection of a pyemia-stricken hospital no other remedy than the pick."[2]

Lister's first case to be done by the antiseptic method in which he opened the skin for the drainage of an abscess and obtained healing, without a complicating or mixed infection, was of particular interest. It is striking, even at the present time, because of the fact that the important

[2]Erichsen. John Eric: Hospitalism. and the Causes Which Determine the Mortality after Amputation, Lancet, London. 1: 223, February 14, 1874.

lesson which it teaches is still unlearned as far as a great part of the medical profession is concerned. In this case, after a careful preparation of the skin over a large psoas abscess, Lister evacuated a considerable amount of tuberculous pus and immediately covered the opening with a 25 per cent carbolic acid pad. At the time of the operation, and subsequently, the wound was protected against the invasion of any complicating microorganisms. In other words, by following the theoretical methods at which he had already arrived, Lister successfully prevented a mixed infection of a tuberculous abscess, the patient healing primarily and making a recovery.

Even in our day it is common to see such an abscess incised under less than perfect surgical conditions, and to see the area squeezed and dressed secondarily in such a way as to give the patient a mixed infection. This is often a serious or even fatal complication.

This is only one of the ways in which Lister's teachings have been misunderstood or misapplied. It is of the greatest importance even now to study most carefully the fundamental principles involved in the Lister method. As it is sometimes expressed, it is important for the surgeon to develop an "aseptic conscience." One of the important things for us to bear in mind is that Lister himself had no conception of what we now speak of as hematogenous infection. He did not realize that infection might be carried from one portion of the body to another in the blood stream, and establish apparently primary infection under unbroken skin or set up secondary infection at another point. Neither did Lister properly appreciate the body defenses against infection; he apparently felt that our battle with infectious microorganisms must be made entirely on the outside. That impression unfortunately is one which has been largely prevalent in the medical profession ever since that time. The attempt to control infection entirely by means of chemicals on the outside of the body has not been a success. The Listerian principle as applied to the preven-

tion of infection by the use of antiseptics to exclude organisms was the most important fact for which we are indebted to Lister.

The epoch-making paper, which recorded Lister's first observations on the antiseptic system of surgery, appeared in the *Lancet* between March and July, 1867. It bore the title "On a New Method of Treating Compound Fractures, Etc., With Observations on the Conditions of Suppuration." His scrupulous attention to phraseology is shown by the fact that he was in great doubt whether to use the word "conditions" or "causes," and he discussed the matter with his father at some length.

In promulgating his antiseptic system, Lister was greatly handicapped by the fact that the establishment of his technic as a clinical method depended so largely upon the clinical results; that is to say, one must see the patients and must be familiar with results in order to know that one method is better than another. As the results accumulated, indicating the difference in the conditions of patients and the kind of results obtained before Listerism and afterwards, the recognition of Lister's achievement became greater and greater. For a long time, however, it seemed that Lister's attitude was wholly one of criticism of his professional associates and their methods. This, of course, made the establishment of his new method a matter of great difficulty.

Even the hospitals began to take on an entirely different appearance; one finds this frequently referred to and Lister himself began to speak of it in his papers. He said:

"There is, however, one point more that one cannot but advert to—namely, the influence of this mode of treatment upon the general healthiness of a hospital. Previous to its introduction, the two large wards in which most of my cases of accident or operation are treated, were amongst the unhealthiest in the whole surgical division of the Glasgow Royal Infirmary, in consequence, apparently, of those wards being unfavorably placed with reference to

the supply of fresh air; and I have often felt ashamed, when recording the results of my practice, to have so often to allude to hospital gangrene or pyemia. It was interesting, though melancholy, to observe that, whenever all, or nearly all, the beds contained patients with open sores, these grievous complications were pretty sure to show themselves; so that I came to welcome simple fractures, though in themselves of so little interest either for myself or for the students, because their presence diminished the proportion of open sores among the patients. But since the antiseptic method has been brought into full operation, the wounds and abscesses no longer poison the atmosphere with putrid exhalations, my wards, though in other respects under precisely the same circumstances as before, have completely changed their character; so that during the last nine months not a single case of pyemia, hospital gangrene, or erysipelas has occurred in them.

As there appears to be no doubt regarding the cause of this change, the importance of the fact can hardly be exaggerated.''[3]

Many antiseptic substances were brought to Lister's notice and were subjected by him to the most stringent tests, both as regards antisepsis and also as regards the irritation of wound surface and skin. At that time bacteriology was practically non-existent, and scientific tests could not be made with the same precision as at the present day; but Lister subjected them to severe practical tests. He said, ''I want to know whether these chemical substances will irritate the skin or the wound, how they will behave in serum and blood, which are my cultivating media (not in Pasteur's solution, or other artificial media), whether the gauze can store enough antiseptic to prevent growth of bacteria in the blood and serum which pass through it, and so on.''

In view of what follows, it is important to notice Lister's views about antiseptics in their relation to his other sur-

[3]Lister: Collected Papers. 2: 45, 1909.

gical principles. About the earliest treatment of compound fractures with antiseptics took the form of a swabbing out with a small piece of lint saturated with undiluted carbolic acid, followed by a dressing similarly prepared. Over the dressing was placed a strip of tin, properly bent. The acid and the blood combined to form a scab underneath the dressing. And it is important to recall that, while the region around the crust and even the crust itself were gently painted over with carbolic acid, the wound itself, underneath the crust, was not disturbed.

When Lister came to use his "antiseptic putty," the principle of his dressing was the same. The putty was spread upon calico, and between the wound and the putty was a piece of lint soaked in carbolic acid. "The dressing of putty was changed daily, but the piece of oiled lint, harboring under it a crust of blood, of greater or less amount, was not interfered with."[4]

Later on, Lister sought further improvements and alighted upon his antiseptic lac plaster consisting of a mixture of one part carbolic acid in four parts of shellac, spread in thin layers on calico and covered over with a solution of india-rubber in benzine. When the benzine evaporated, there was left the thin layer of india-rubber to prevent adhesion of the plaster to the skin, but not interfering with the action of the antiseptic. But even with this dressing, Lister held to his practice of letting the wound alone. "No one," we are assured, "has ever recognized more fully than did Lister the necessity of limiting the irritating effects of the chemical substances employed in the treatment."[5]

The Listerian system developed and passed through the stage of the antiseptic spray. This, as we all know, he discarded. And in his presidential address before the British Association in 1896, Lister makes the following comment:

[4]Cameron, Sir Hector C.: A Short Account of the Evolution of Lister's System of Antiseptic Surgery. Handbook of the Lister Centenary Exhibition at the Wellcome Historical Medical Museum. London, 1927, p. 16.

[5]Cameron: Ibid. p. 18.

"I was led to conclude that it was the grosser forms of septic mischief, rather than microbes in the attenuated form in which they exist in the atmosphere, that we have to dread in surgical practice; and at the London International Medical Congress in 1881, I hinted, when describing the experiments to which I have alluded, that it might turn out possible to disregard the atmospheric dust. But greatly as I should have rejoiced at such a simplification of our procedure, if justifiable, I did not then venture to test it in practice. I knew that with the safeguards which we then employed, I could insure the safety of my patients, and I did not dare to imperil it by relaxing them. Nine years later, however, at the Berlin Congress of 1890, I was able to bring forward what was, I believe, absolute demonstration of the harmlessness of the atmospheric dust in surgical operations. This conclusion has been justified by subsequent experience; the irritation of the wound by antiseptic irrigation and washing may therefore now be avoided, and Nature left quite undisturbed to carry out her best methods of repair."

And he adds soon afterward, in a letter to Pasteur: "Next to the promulgation of new truth, the best thing that I can see that a man can do, is the recantation of a published error."

The history of the use of antiseptics since Lister is at once comic and tragic. Great progress has been made, as we all recognize, in the sterilization of dressings by steam, in the use of milder antiseptics, and in aseptic and antiseptic surgery generally. On the other hand, however, the tendency has been to run the use of antiseptics into the ground. A supreme faith in the universal efficacy of chemicals has led us to use them unreasonably, and to the total disregard of other more important surgical precepts. This sort of "Listerism" is not Listerism at all; and it has had consequences that are appallingly unsurgical.

American surgeons generally have followed the modified Listerian method devised by Dr. T. M. Markoe, of New

York. To this method we are indebted for nearly all of the flushings, packs, poultices, and drainage tubes with which wounds have been treated in this country for a generation. The Markoe modification of Lister's antiseptic method violated at least two of the teachings which Lister himself considered of fundamental importance: protection of the wound surface from the air and avoidance of direct application of chemicals to the wound. Markoe's method is described in his own words quoted and commented upon by Dr. B. A. Watson:

"The plan itself consists in the free and constant use of appropriate solutions of carbolic acid in water, no care being taken to keep the wound cut off from the influence of the atmosphere, and provision being made for the inner surface and cavities of the wound being constantly, or at least frequently, moistened by the carbolic acid.

"This is the outline of the plan, but its details can perhaps best be presented by describing its application to a case in which the operation was performed for the removal of a dislocated and diseased astragalus. . . . The wound, which consisted of a semilunar incision extending from behind and below the internal malleolus, was dressed by bringing the edges together with carbolized silk sutures, a long drainage tube having first been passed across the deeper part of the wound from one malleolus to the other. This tube had been prepared so that the part within the wound had been perforated with a number of holes, care being taken that all that part of the tube which projected from the wound should be free from openings. The wound was then covered with the ordinary prepared carbolized gauze laid on in three or four thicknesses, first being well wetted with one-fortieth solution of carbolic acid, and so arranged upon the surface of the wound that the ends of the drainage tubes were free as they projected on either side. This we generally accomplished by cutting holes in the dressing opposite the points of entrance and exit of the drainage tube, though sometimes the tubes could be

brought out between the folded pieces of which the dressing was composed. This, retained in position by a few turns of the thin gauze bandage, also wetted with carbolic acid solution, completed the dressing. The limb was then suspended from a framework so that it was raised about six inches from the bed, and swung easily from side to side on every motion of the patient's body. This arrangement was found extremely comfortable, and permitted the drainage from the wound to be freely discharged from the lower opening. Four times a day a solution of one-fortieth carbolic acid was thrown through the drainage tube with an ordinary syringe, and continued until the fluid discharged at the lower opening was perfectly clear. The result of this manipulation was that the fluid forced by the syringe into the upper end of the tube found its way freely into the cavity of the wound distending it, and then found its way out at the lower orifice carrying with it all the fluid secretions which otherwise would have been more or less confined within the wound. This distention of the wound by the injected fluid would not of course happen to any great extent if the whole tube, including its lower orifice, were free from obstruction, but it very often happened that the outlet was impeded by plugs of dried pus or clots, and then the penetration of the fluid to all the recesses of the wound was very complete—a penetration which we considered so desirable that sometimes the lower orifice of the tube was pinched by the finger and thumb, while the injection was being made, for the express purpose of securing it."[6]

This passage provokes the following comment from Dr. Watson:

"We have now presented, in the author's own words, the essential parts of his method of wound treatment, which he has offered as a modification of the Listerian system, in order that we may justly compare it with that which he

[6]Markoe, T. M.: "Through Drainage" in the Treatment of Wounds, Am. J. Med. Sc. 79: 305, 1880.

styled "the true and only gospel of the surgery of wounds." We have neither the time nor the inclination at this moment, to discuss fully the principles or theories on which these different plans of wound treatment are based. It should, however, be remembered that the Lister system of treatment aims to secure the highest possible degree of rest for the wound, and likewise immunity from septic complications."[7]

Dr. Watson was clearly quoting Markoe only to prepare the way for his own criticism. That he himself properly appreciated the teachings of the great Lister is indicated by the following remarks:

"Having now summarily alluded to some of the studies, experiments, and observations which were preliminary to the application of the germ theory of the treatment of wounds, it now remains for us to examine into the basis and character of Lister's treatment. This treatment is based especially upon the following conditions:

"First, the continued exclusion from wounds of all living germs, or the prompt destruction of the same in those cases where they have gained admission, thus preserving in the wound an absolutely aseptic condition until it has healed.

"Second, complete and uninterrupted approximation of the wound surfaces.

"Third, the avoidance of all irritation or any disturbance of the relation of the wounded parts."[8]

But the fundamental soundness of this one man did not prevail against the force of Lister's camp followers, and the early attempts to follow Lister—seemingly by forgetting what he had taught—and indeed the attempts of the present, evince a departure from the teachings of him who first thought out a proper application of the discoveries of

[7]Watson, B. A.: Lister's System of Aseptic Wound Treatment Versus Its Modifications, Tr. Am. Surg. A. 1: 207, 1880-83.

[8]Watson: Ibid. p. 207.

Pasteur to surgery; the various attempts at improvement upon Lister's antiseptic method have not improved upon Lister's results.

It must be confessed that the profession was slow to adopt Listerism, but Markoe's "Through Drainage" with partially sutured wounds and rubber tubes has become the universal method of using the antiseptic method. Every possible substance has been put into solution or suspension for employment as a form of wound irrigant or poultice. Records of the American Surgical Association reveal, in the discussion of Dr. Watson's remarks quoted above, a marked scepticism towards the Lister method. But this reflects little enough credit on the profession, for they, no more than Markoe, understood the real message of Lister. It is now apparent that neither Lister's theory nor his method of practice were properly understood in this country, and Lister himself more than once commented sorrowfully upon that fact.

Since the time of Lister, the usual conception of the best means of treating wounds has been that infection must be met in the wound and defeated by antiseptics. But it should be remembered that infections of all kinds had been successfully overcome long before the time of surgeons or antiseptics. A study of the fossil remains of prehistoric animals reveals the presence of healed lesions of bone and joint infections of many kinds. Out of our present day notion as to the importance of antiseptics, there have developed certain errors in surgical practice to which it is necessary to call attention and for which it is desirable to propose a remedy.

In our use of antiseptics there undoubtedly has often been the same misapprehension with regard to cause and effect that obtains and has obtained in the use of other substances used as remedies in other kinds of disease. We have had occasion to try and to abandon hundreds of substances which were at one time relied upon as curative. Now we know that in diseases of many kinds recovery

takes place quite regardless of the medicinal agents employed. If we scrutinize the methods employed in wound treatment, we shall have reason to doubt whether it has been generally discovered or recognized that infected wounds do heal without the application of antiseptic agents of any kind.

Before the antiseptic period the usefulness of certain agents in preventing fermentation of all kinds had been demonstrated in many ways. For the preservation of human bodies after death, there had been developed methods over which very little improvement has been made. The control of fermentative processes outside of the body was being given considerable attention, although no high degree of perfection was reached until the discoveries of Pasteur. Substances and combinations similar to those used in embalming had been used to a certain extent in the treatment of wounds. They were used, for the most part, empirically because they seemed to promote healing.

Lanfrank, in the fourteenth century, had formulated quite definite and fairly successful methods of dealing with simple and infected wounds. He advocated and employed compresses, sutures, and special dressings for wounds of various kinds. He quoted from both Galen and Avicenna to emphasize the point that no attempt must be made to close septic wounds until they had been cleaned up.

Lanfrank reports a case in which primary healing occurred and says: "I found the wound and the vein all healed and the father and all the neighbors had great wonder."[9]

One encounters the same sort of astonishment whenever patients are seen who are recovering from infected wounds without active antiseptic treatment. It has, somehow, become a notion prevalent among the laity, as well as current in the profession, that a certain amount of treatment with poultices, packs, irrigations, or antiseptic

[9]Lanfrank: Science de Cirurgie, Ashmole MS., 1396, Early English Text Society, Original Series 102, London, 1894, Part I, p. 68.

powders or pastes is necessary to persuade a wound to heal. The healing of a wound without any of these things is usually looked upon as an interesting and unusual phenomenon.

Since the time of Lister there has developed, as we have seen, a disposition on the part of the profession to regard wound treatment as a contest between the germs in the wound and the antiseptic that is being employed. For severe infections more and stronger antiseptics! To a certain extent the facts have been lost sight of that, on the one hand, with every infected wound there is a certain amount of septicemia against which the patient must battle himself, and which also may become better or worse according to the wound treatment employed; and that, on the other hand, not only may the antiseptic treatment employed be entirely inadequate to cope with the infection, but that it may be more irritating than beneficial to the patient. Moreover, along with the so-called antiseptic dressings, additional infection may be introduced into the wound from the air, from soiled dressings or instruments, or from the fingers of the one who is applying the dressing. Many of these points have received too little consideration. Finally, and more important, is the point that as a factor in the treatment of any inflammed process, rest has long since been demonstrated to be a therapeutic agent of great importance. Rest for the wound means infrequent dressing; rest for the injured or inflamed part of the body means protection against movement, relief from muscle spasm, relaxation in correct position—that is to say, efficient immobilization.

Dr. Singer, in her life of Paré, directs our attention to the methods of wound treatment worked out by Paré and by his predecessor, Joubert (1570). Joubert was a skilled medical botanist and a learned physician. Toward the end of his life, he employed only pure spring water as his dressing for wounds. Commenting upon this, Paré said:

"As for some empiricks who cure simple wounds merely by application of linen, either dry or soaked in water, and sometimes cure them, it is not necessary to believe there is enchantment, or a miracle, as do idiots and the populace, but merely in the beneficent action of nature, who cures wounds, ulcers, fractures, and other ills. For the surgeon does no more than aid her by removing the hindrance, as pain, flexion, inflammation, and infirmity or other things that cannot be moved by nature alone."[10]

The experience of Paré which led to his simplification of wound treatment is quite generally known. The prevailing treatment for gunshot wounds in his day was cauterization with boiling oil. On one occasion, the supply of oil having been exhausted, he related the following experience: "It chanced on a time, that by reason of the multitude that were hurt, I wanted this oyle. Now because there were some few left to be dressed, I was forced, that I might seeme to want nothing, and that I might not leave them undrest, to apply a digestive made of the yolke of an egg, oyle of Roses, and Turpentine. I could not sleep all that night, for I was troubled in minde, and the dressing of the precedent day (which I judged unfit) troubled my thoughts; and I feared that the next day I should finde them dead, or at the point of death by the poyson of the wound, whom I had not dressed with the scalding oyle. Therefore I rose early in the morning, I visited the patients, and beyond expectation, I found such as I had dressed with the digestive onely, free from vehemencie of paine to have had good rest, and that their wounds were not inflamed, nor tumifyed; but on the contrary the others that were burnt with scalding oyle were feaverish, tormented with much paine, and the parts about their wounds were swolne. When I had many times tryed this in divers others I thought this much, that neither I nor any other should ever cauterize any wounded with Gun-Shot."

[10]Singer, Dorothea Waley: Ambrose Paré, London, 1924, pp. 62-63.

By the work of Hilton[11] (1807-1878) and Thomas[12] (1837-1891) we are taught the control of inflammatory processes by methods designed to conserve body resistance. Hilton and Thomas, better than any others, have demonstrated the tremendous ability of the body forces to deal with infection. Hilton showed over and over again the value of rest in combating chronic, or, what we might call low grade, infections. He proved that prolonged rest was *the* therapeutic agent of importance. Following Hilton, Thomas was the first to work out a satisfactory method and the accompanying appliances by which rest could be obtained. With the advent of Pasteur and Lister we had the opportunity, which, in the mind of the present writer, has never been taken advantage of, to apply the principle of rest to the treatment of the more acute and more severe infections, especially to compound infected wounds of the bones and joints. Lister certainly showed us the way to the prevention and, to a certain extent, the control of the putrefactive and parasitic processes resulting from the invasion of wounds by septic microorganisms.

What has happened in recent practice is that to a large extent the value of rest in its best sense has been forgotten. Listerism has been construed to demand active chemical antiseptic treatment of wounds. The greatest possible confusion has prevailed as to the methods by which chemical antisepsis is to be obtained.

Keyes, in 1902, was endeavoring to compromise the various methods that had been proposed. Speaking of compound fractures, he said, for example:

"The splint should be applied to the limb before the patient leaves the operating table. If the wound is expected to run a clean course, a fenestrated plaster encasement is best, reinforced if necessary, by iron bands. If, however, suppuration is feared and daily dressings are ex-

[11]Hilton, John: Rest and Pain (Ed. W. H. A. Jacobson). Ed. 5, London, 1892.

[12]Thomas, Hugh Owen: Contribution to Surgery and Medicine. Part II. Principles of the Treatment of Diseased Joints. London, 1883; Part IV The Principles of the Treatment of Fractures and Dislocations. London, 1886.

pected, such a splint soon becomes soiled and soaked with discharge from the wound, in spite of every precaution. . . .

"The treatment of wounds is of the greatest importance, while the primary irrigation and antisepsis are chiefly to be depended upon to prevent infection, the *irritation as well as the danger of infection from the frequent change of dressings is a common cause of the late suppuration.*"[13]

Keyes concludes, however, in the manner common to the practice of the present time with the following:

"If the wound is but loosely sutured and lightly packed in the first place, it may sometimes be left undisturbed until the fourth day. If at the first dressing the wound is clean, it should be disturbed as little as possible. Some of the drainage may be removed. The *wound should not be irrigated.* After this the dressing is renewed at intervals of from forty-eight to seventy-two hours until the wound is healed. If active suppuration occurs *it must be combated by the usual antiseptic methods.*

"If drainage has been used the wound should be dressed at the end of twenty-four to forty-eight hours, and the gauze or tubes removed.

"The appearance of infection in a wound demands the establishment of *free drainage and the use of antiseptic irrigation.*[14] The application of a hot moist antiseptic dressing will often prove beneficial."[15]

Speaking of suppuration and sepsis, Keyes says:

"These complications are confined to compound fractures. To treat them judiciously may tax the keenest surgical instinct, for in many cases the suppuration is at first slight and the constitutional disturbance insignificant. To leave the wound unirrigated is to invite extension of the infection throughout the lacerated tissues, while to irrigate freely is to break down fibrinous adhesions, to bruise granulations, and to irritate the whole area to such an extent

[13]Keyes, Edw. L., Jr.: Fractures, Woods Ref. Hand Book of the Medical Sciences. 4: 256, 1902.

[14]Italics the author's.

[15]Keyes: Ibid. p. 257.

as enormously to encourage infection. To steer between the two is less a matter of intelligence than of instinct derived from experience. If the infection promises to be slight, and occurs later than the fourth or fifth day when healing has already progressed so far as to afford a barrier to the spread of suppuration, the pus may simply be mopped away and the cavity swabbed out with peroxide of hydrogen and packed with bichloride gauze (1 to 2,000) or one of the newer organic silver salts. If, however, the infection occurs early or presents other grave features, there is nothing for it but to irrigate the wound copiously (one to two quarts of bichloride solution 1 to 10,000) once and thereafter to change the dressings frequently in the hope that the infection may thus be repressed or at least confined to one spot.

"The milder infections may be conquered by these local measures. The more virulent processes require wet dressings, antiseptic baths, multiple incisions, continuous irrigation, or even amputations. As already stated, the union of the bone is delayed by the infection as well as by the manipulations, but I have known union to take place in the femur in two cases after a year of hospital treatment. Such a result could not be expected in an old man. He would not survive the prolonged suppuration."[16]

The above paragraphs represent the tendencies of wound treatment as carried out by most physicians and surgeons at the present time. Even a clean wound is scarcely permitted to rest; and if infection supervenes or exists at the beginning, all considerations of splinting or immobilization (rest) are cast to the winds in the interest of irrigation, packs, and the like.

Listerism, as applied to the performance of aseptic operations, has been perfected and improved to a remarkable degree. But Listerism as applied to the treatment of infected wounds in general practice nowadays is scarcely

[16]Keyes: Ibid. p. 257.

as good as in the days of Lister himself. It must be understood that Lister conceived of antiseptics as a means of preventing rather than controlling putrefaction. Lister says, "For it is hardly needful to point out that neither the spray nor the carbolic oil applied externally, nor the oiled lint inserted in the outlet to serve as a drain, could correct putrefactive fermentation once established in the abscess cavity. Here, as in the antiseptic treatment generally, the means are calculated to prevent, not to correct, putrefaction."[17]

Primary asepsis and the protection of the wound for which Lister contended so valiantly, have been to a large extent forgotten in the restless quest for a method or agent which would do what no agent so far has ever done, namely, sterilize an infected wound without damaging the patient. Listerism properly understood and properly applied has conferred countless benefits upon surgical patients and has enabled the surgeon to go far with his operative methods and his surgical technic. Listerism misunderstood and badly applied has, on the other hand, inflicted an immense amount of suffering upon patients with infections and has been responsible for deformity and disability that could have been prevented by less strenuous and more thoughtful treatment.

One must not give the impression that Lister perfected the antiseptic method, or that all surgeons since Lister have misunderstood and abused his teaching, or that every use of antiseptics at the present time is probably wrong. The advent of Listerism was undoubtedly one of the greatest forward steps in the history of surgery. The difference in hospital conditions, in the death rate, in the suffering of patients in all phases of surgical treatment makes impeccable testimony for the sublimity of Lister's legacy to humanity; but there has been the other side, and the other side remains. It is this other side that is being

[17]Lister: On Recent Improvements in the Details of Antiseptic Surgery, Lancet, London. 1: 402, March 29, 1875.

emphasized here because of its consequences to surgery and particularly because it represents a Listerism that is not Lister's.

Wound surgery at the present time is in almost as chaotic a condition as was medicine in the days when frogs, snakes, and puppies were used for medicinal ingredients. Every conceivable substance and combination of substances has been tried out for their germicidal and antiseptic qualities. The simple expedient of affording the body its best chance to resist infection is the one thing that has not been thoroughly tried. One realizes, of course, the great possibilities latent in antitoxic and vaccine treatment; but until we know germs and their habits better than we do now, we cannot rely upon such measures in the care of wound infections and septicemia. Protection of wounds, however, we may achieve fairly well if we will. Our error has been that, contrary to Lister's teachings, we have not been content to stop with protective measures; we persist in regarding a wound as a battle ground, and we oppose the forces of antiseptic solutions to the regiments of disease germs, totally oblivious of the damage we are doing to our strongest allies, the bodily reserves which are ours by nature and which would win for us if we gave them half a chance.

Summarizing the grievances against this decadent sort of Listerism, we may point out: first, that many of our poor results in acute and chronic infections of bones and joints are due to our neglect of rest and other fundamental surgical principles in the interest of this pseudo-Listerism which takes the form of daily dressings, drainage tubes, and wound irrigation; second, that these things are unnecessary and often injurious for the reason that a wound primarily clean or cleaned up will take care of itself and that the daily tampering to which we subject wounds gives rise to secondary mixed infections which delay healing and play havoc with the orthopedic results desired; third, that Lister limited the use of antiseptics to the primary stage

of making the wound aseptic: knowing the value of rest and the efficacy of bodily forces in healing, he was content to let a clean wound take care of itself; and fourth, that a beneficent Listerism making possible aseptic surgery and creating ideal conditions for healing should not be perverted into a Listerism which calls for interference and tampering when a wound has begun to heal, for such tampering gives rise to an extension of primary infection, mixed infection, secondary foci, delayed healing, deformity and permanent disability. We have learned much from Lister and have gone beyond him in many respects, but our enthusiasm has carried us too far, and under his name we defy surgical principles which he recognized as fundamental and which still are fundamental. It is here that we must turn back.

CHAPTER II

Lessons From the Great War

Although there were notable advances in the wartime practice of surgery before 1914, particularly in the Russo-Japanese War, it was nevertheless the Great War that provided for surgery a tremendous laboratory and clinic in which to test the most modern developments of post-Listerian surgery. War conditions are, of course, exceptional; but they offer the severest tests of human ingenuity. The great numbers of wounded, the exceptional seriousness of injuries, the frequent inadequacy of materials and equipment, and so on, created situations that only emergency measures could cope with. Exceptional as the war conditions may have been, however, they taught surgeons many lessons. Some of these lessons are of present interest.

The military lessons of the world war probably vary in direct proportion with the number of men who had different experiences and saw different phases of it. This is no less true when applied to war surgery. And as a result, we have been flooded with accounts of the lessons of the war. To me some of these accounts seem true; other false. To me the true lessons of the war, surgically speaking, are not those we usually hear about. The succeeding pages will recount the experiences that led to this conclusion that as a profession we have learned neither from the various wars since the advent of Listerism nor from civil practice since the world war how properly to treat infected wounds and infected bones and joints.

At the time of the military draft in 1917, out of the first million and a half men examined, an astonishing amount of disability in the extremities as the result of ununited and malunited fractures and infections of the bones and

joints was found. Forty-five thousand men, or 2 per cent of all those examined, were found to be seriously disabled on account of these conditions. In the Surgeon General's report the causes were said to be "the liability to accident to which young men are subject often in localities where a good surgeon's attendance cannot be secured." The percentage of disability for urban and rural cases does not differ as widely, however, as might be inferred from the above comment. It was found, in fact, that with respect to malunion of fractures, a condition in which a decided percentage in favor of cities might be expected, no such difference developed. For ankylosis of joints following injury and disease, the comparative percentages are also interesting:

	Urban	*Rural*
Malunion of fractures—upper extremity	1.5	1.6
Malunion of fractures—lower extremity	2.2	2.7
Ankylosis of joints	3.2	3.5

Other observations which I made seem to bear out the general conclusion that differences in disability following fractures and the treatment of other bone and joint wounds do not arise from differences in skill between individuals or groups in the medical profession, but that the shortcomings in treatment which lead to disability are common to the profession as a whole. These faults as revealed by the present investigation are several: first, the tendency to pay earliest and principal attention to the antiseptic treatment of wounds by pads, packs, irrigations, and the like; and second, to neglect those fundamentals essential to obtaining and maintaining correct length, position, and rest for the injured and infected parts. Observations during 1917-1919 in Great Britain and France bear out the conclusion that poor results come from poor procedure in general rather than from inequalities among surgeons.

Conditions in Great Britain in 1917 were such that every possible sort of antiseptic and many methods of applica-

tion were employed, while thousands of men lay in hospitals for months for the dressing of chronic infected wounds, particularly of the bones and joints. It was a rule that men should not be discharged from the army with unhealed sinuses; accordingly many of them had been in hospitals during all or a good share of the then two and a half years of the war. There were large numbers of neglected cases; neglected from the orthopedic point of view through the lack of a definite technic of treatment. One might find cases of chronic osteomyelitis with gunshot and shell wounds not yet adequately drained. There were ununited and malunited fractures, poorly splinted or not splinted at all. There were gunshot wounds of the wrist and ankle in which healing was going on with hands in palmar flexion and feet in plantar flexion. All this in spite of the efforts of Sir Robert Jones and his aides to command adherence to sounder surgical and orthopedic principles.

Where such principles were being observed, good results might be found. Considerable progress had been made, for example, in the emergency treatment of patients with fracture of the femur. It was a matter of record that during the first year of the war about 60 per cent of all the men who sustained gunshot wound fracture of the femur died. With the inauguration of the emergency splinting of these patients on the battle field with the Thomas splint, there was an immediate marked improvement. By the third year of the war the death rate had been reduced from 60 to about 12 per cent. Now, however, it was found that the ultimate results in these cases were not good enough. There was found to be a large amount of shortening and deformity in the femur and leg cases. This was said to be due largely, if not entirely, to failure to maintain continuity of treatment as good as the first splinting. Somewhere between the advanced dressing station and the base hospital the treatment broke down, and the patients recovered with serious deformity and conse-

quent permanent disability. It was at first supposed that this was the result of the transportation of these patients from France to the British Isles. It was said that an attempt would be made to treat all femur cases in France until union with good length and position had been obtained. Later, however, it was understood that this had been found to be impracticable, and the patients were brought as before to the Base Hospitals in Great Britain for treatment. There was, however, as a result of a "shaking up," an immediate improvement in the treatment of these cases; and there was a corresponding improvement in the character of results. The principal factors in this change were the more general efficient use of the Thomas splint, the employment of traction by ice tongs, and certain other measures that came to be insisted upon in the orthopedic and other hospitals. It was just such hard-won lessons as these that were to be of such use to the American wounded in their own hospitals in France.

By spring of 1918, some sixty to seventy American medical officers had been assigned for duty in the British Orthopedic Centers. They were assigned with a double purpose: that they might help as much as possible in caring for the British wounded and that they might learn and apply in American Centers, when the proper time came, the improved methods of the British, developed in their two and a half or three years of war experience.

The American medical officers had also been given an opportunity to familiarize themselves with the excellent splinting methods employed by all the assistants and disciples of Sir Robert Jones. This experience was not only with the ring Thomas knee splint, which had proved so successful in the treatment of fractures of the femur, but with the long and short posterior irons for ankle joint, knee joint, sciatic nerve, and hip injuries; the Jones humerus traction splint for upper arm and elbow injuries; and the long and short cock-up splints for forearm, wrist, and hand injuries, and the like. All of these splints were

being employed in the British hospitals with or without surgical operations, and a tremendous amount of deformity was being prevented or overcome.

Already the work of the Orthopedic Centers had made a considerable impression upon all the surgeons in the British Isles. It was hoped, therefore, that the experience which had resulted in considerable progress in the surgery of injuries in Great Britain might be passed along to the Americans as promptly as possible. In this way valuable lives and limbs might be saved without the bitter experience the British had had during the first year or two of the war. Despite the advantage of such training, however, the first efforts of the Americans did not yield the results they might have. It was some time before the "orthopedic idea" could be made effective in France.

The problems confronted in France by the Americans were like those faced earlier by the British. A wide disparity in the results of the various hospital areas led to recommendations for the standardization of treatment of orthopedic cases, and the poor condition in which some wounded soldiers were being returned to the United States called for the appointment of a number of orthopedic consultants whose duty it was to determine which patients should and which should not embark for the States. In this manner there came to be a considerable extension of the orthopedic treatment of wounds and injuries.

In what did this change of attitude consist? The American officers who observed the war injured as they were most ideally treated in England soon noticed that the British were paying attention to the following problems: (1) methods of immobilization for compound infected bone and joint injuries; (2) the cleaning up of infected wounds involving bones and joints; (3) the correction of late deformities after injuries to bones, joints, and soft parts; (4) the repair of peripheral nerve injuries; (5) postoperative splinting by the methods of Hugh Owen Thomas and Sir Robert Jones, and (6) the rehabilitation of war cripples

by vocational training. The orthopedic point of view, as it gained prestige, consisted in the observance of such principles of treatment. How this was done in one surgical area in France is contained in the following communications which may prove of interest.

Some of the first patients returned to the United States arrived in such poor condition that the following instructions were issued from the office of the Surgeon General:

Hq. Hosp. Center Savenay,
27 November, 1918.

MEMO NO. 165

The following telegram is quoted for the information and guidance of all concerned:

CO. HOSPITAL CENTER SAVENAY—

2111

TO COMPLY WITH CABLED INSTRUCTIONS WAR DEPT., NOV. 23, 1918 A MORE CAREFUL SELECTION OF PATIENTS FOR RETURN TO THE UNITED STATES WILL BE MADE. NO CASE OF AMPUTATION COMMA BONE COMMA JOINT INJURY OR OTHER ORTHOPEDIC CONDITIONS WILL BE SENT TO THE U. S. WITHOUT APPROVAL OF ORTHOPEDIC CONSULTANT OF THE AREA.

McCAW.

By direction:
C. S. ADAMS,
1st. Lt. San. Cps. Adjt.

The following note is suggested by Colonel Joel E. Goldthwaite, Chief Consultant in Orthopedic Surgery, A. E. F.:

"The above telegram was, in part at least, the direct result of the conditions which followed a blunder upon the part of someone in sending several trainloads of patients direct to ships for the United States without preliminary treatment to prepare them for transportation. These patients went through a port at which no organization for the inspection and treatment of patients destined for the United States had been perfected, and the unfavorable condition of the patients for transfer to the United States was so apparent that another organization similar to the one which had been in operation at Savenay was prepared

and placed in charge of the port through which, from that time forward, patients were to be sent from France to the United States."

The method of dealing with these cases already adopted at Savenay enabled those on duty in Base Section No. 1 to comply with these instructions immediately. In fact, the bulletin sent out by the Consultant Orthopedic Surgeon previously indicates that serious consideration had already been given to that problem:

Nov. 20, 1918

From: Consultant in Orthopedic Surgery, Savenay.

To: Chief of the Surgical Service Base Hosp. No. 8.

Subject: Orthopedic Patients.

Sir:

Since September 1, a statistical study has been made of patients arriving in Savenay for evacuation to the United States. The conclusions reached and to which it is desired to call your attention in this communication are based upon the observation of somewhat more than 4,000 cases.

It has been found that about 350 patients of each 1,000 arrive in condition for immediate transfer to the United States, requiring no treatment or splinting of any kind. About 200 of each 1,000 arrive wearing proper splints. Some require simple surgical dressings. A few patients of this class require drainage operations but most are ready for transfer to the United States within a few days.

Three hundred patients of each 1,000 require extensive modification or complete change of splints with or without other treatment. The majority belong to two classes: (a) Gunshot wounds of the upper arm or elbow (75 to 100 per 1,000 of all cases), (b) Gunshot wounds of the hip, femur shaft or knee (also about 75 per 1,000 of all cases). A large percentage of all these cases require readjustment of position under anesthetic, additional drainage, change from straight Thomas arm splint to some device with the elbow in flexion and the hand in supination, application of new Thomas traction splints for femurs, etc. Also a considerable factor under this same heading is that of G.S.W. of wrist and hand with palmar flexion and G.S.W. of the ankle and foot with drop foot. These two classes of injury contribute approximately 35 to 50 cases respectively per 1,000.

Finally 250 cases per 1,000 arrive at Savenay without splints for whom either with or without preliminary operation or readjustment of position, the application of splints is necessary. This class includes practically every kind of war injury, although naturally most of the severe conditions have been dealt with in preceding hospitals. Some of the more important items may be briefly mentioned.

First: G.S.W. of the shoulder with fracture (about 20 per 1,000 cases). For this condition it is frequently advisable to apply an abduction splint (Aeroplane splint).

Second: G.S.W. injuries of the median, musculospiral or ulnar nerves (20 per 1,000 cases).

Third: G.S.W. of the hip, and the shaft of the femur (50 to 75 per 1,000 cases).

Fourth: G.S.W. of the knee (25 per 1,000 cases). It has been observed that knee joint injuries are likely to come without splints, especially the convalescent cases. For bed patients, plaster of Paris or the Thomas splint and for walking patients the walking caliper splint should practically always be put on to be worn during the trip to the United States.

Fifth: In compound leg fractures (75 cases per 1,000) readjustments of position have been more frequently necessary than in any other injury. Neither the Thomas traction splint nor the usual leg splints have proved adequate to maintain, while traveling, length and position in these difficult fractures. Having due regard for wounds, plaster of Paris is especially to be considered in this class of cases. Skillfully applied it has been found to serve the purpose much better than anything else.

Sixth: Soft part wounds of the upper and lower extremities (respectively 40 and 50 per 1,000 cases) also very commonly arrive at Savenay requiring change of splints either with or without preliminary stretching and with or without anesthetic. Contracture deformities of the knee are much more common than any other deformity of this class.

In general then, it may be observed that our experience justifies the conclusion that of each 1,000 orthopedic patients arriving at Savenay, approximately 500 require change of splints or the application of new splints and that of these ¼-⅓ require preliminary operation consisting of readjustment of positions or drainage.

It must be assumed that any unit now working in Savenay doing less work along these lines than is indicated above, is falling short of the requirements of its patients. One of the first things necessary is to locate patients requiring such attention as they come into the hospital. Only in this way can they be promptly and effectively dealt with.

A report along similar lines is being prepared for the amputation service and will be sent to you in due course.

H. W. Orr, Major, M. C. U. S. A.
Consultant in Orthopedic
Surgery. Base Section No. 1. A. E. F.

Patients were arriving from base hospitals in all parts of France, and it was of particular interest to notice the condition of these wounded men as to "position" versus "wound" treatment. A system of checking was instituted whereby the orthopedic staff could be informed of the con-

dition of arriving patients, and the records showed very startling results; to a very large extent the position and function aspects of treatment were being disregarded in the supposed interests of wound treatment.

The accompanying table (Fig. 1) shows the statistics that were obtained from our first month's study of the wounded arriving at Savenay. The figures promptly confirmed the impression already made by the general appearance of the convoys as they came in. The injured limbs were not well immobilized in correct position in one-half of all the cases. Of the actual wounded who required splinting, correction of position, and other treatment, the

PATIENTS RECEIVED AT BASE HOSPITAL NO. 8, SAVENAY SEPTEMBER 1ST TO 28TH, 1918

Showing: Total number from each hospital.
Condition as regards splinting on arrival explained in numbers.*
Condition as regards splinting on arrival explained in per centum.
Remarks: "a" indicates an improvement in later convoys.
"b" indicates poorer condition in later convoys.

NAME	TOTAL	NO. 1	NO. 2	NO. 3	NO. 4	% 1	% 2	% 3	% 4	REMARKS
B. H. No. 1	266	67	29	69	101	25	11	25	39	"a"
B. H. No. 3	86	18	13	20	35	22	15	23	40	"a"
B. H. No. 6	359	135	38	97	91	36	11	27	26	"b"
B. H. No. 7	5	1	0	2	2	20	00	40	40	
B. H. No. 8	3	2	0	1	0	66	00	34	00	
B. H. No. 9	103	51	9	18	23	50	9	18	23	"a"
B. H. No. 11	19	4	2	4	9	20	10	20	50	"a"
B. H. No. 12	1	0	1	0	0	00	100	00	00	
B. H. No. 13	12	4	0	3	5	34	00	25	41	"a"
B. H. No. 14	8	2	1	1	4	25	12.5	12.5	50	"a"
B. H. No. 15	14	2	1	2	9	14	7	14	65	
B. H. No. 17	7	5	0	0	2	73	00	00	27	
B. H. No. 18	8	1	1	4	2	12.5	12.5	50	25	
B. H. No. 19	28	9	1	8	10	32	4	28	36	"b"
B. H. No. 20	24	5	4	4	11	21	16	17	46	"a"
B. H. No. 22	23	13	3	4	3	57	14	15	14	"a"
B. H. No. 23	18	7	3	4	4	39	17	22	22	"b"
B. H. No. 25	15	9	0	0	6	60	00	00	40	"b"
B. H. No. 26	42	9	3	21	9	21	7	50	22	"b"
B. H. No. 27	137	42	19	43	33	31	14	31	34	"b"
B. H. No. 28	25	7	0	9	9	28	00	36	36	"b"
B. H. No. 29	21	1	0	0	0	100	00	00	00	
B. H. No. 30	58	22	4	17	15	38	7	29	26	
B. H. No. 31	21	3	15	2	1	14	71	10	5	"a"
B. H. No. 32	3	2	0	1	0	66	00	34	00	
B. H. No. 34	100	21	23	35	21	21	23	35	21	"a"
B. H. No. 35	2	0	2	0	0	00	100	00	00	

Fig. 1. *(See next page.)*

PATIENTS RECEIVED AT BASE HOSPITAL NO. 8, SAVENAY—CONT'D

NAME	TOTAL	NO. 1	NO. 2	NO. 3	NO. 4	% 1	% 2	% 3	% 4	REMARKS
B. H. No. 36	6	4	0	1	1	66	00	17	17	
B. H. No. 38	27	7	5	8	7	26	8	30	26	"a"
B. H. No. 39	1	1	0	0	0	100	00	00	00	
B. H. No. 40	6	2	0	1	3	33	00	17	50	
B. H. No. 44	9	3	0	0	6	34	00	00	66	
B. H. No. 46	2	1	0	0	1	50	00	00	50	
B. H. No. 48	46	5	8	27	6	11	18	56	15	"a"
B. H. No. 49	2	0	0	0	2	00	00	00	100	
B. H. No. 50	8	3	2	1	2	37	25	13	25	"a"
B. H. No. 66	2	1	0	0	1	50	00	00	50	
B. H. No. 67	131	56	11	20	44	43	9	15	33	
B. H. No. 68	14	4	2	5	3	29	14	36	21	
B. H. No. 101	54	14	5	14	21	26	9	26	39	"a"
B. H. No. 114	71	27	12	12	20	38	17	17	28	"a"
B. H. No. 115	17	7	0	2	8	41	00	13	46	
B. H. No. 116	3	1	1	1	0	33.3	33.3	33.3	00	
B. H. No. 202	4	0	0	1	3	00	00	25	75	
RC. H. No. 1	1	0	0	0	1	00	00	00	100	
RC. H. No. 2	14	3	0	3	8	22	00	22	56	
RC. H. No. 5	5	1	0	2	2	20	00	40	40	
Mil. Hosp. No. 1	1	0	0	0	1	00	00	00	100	
St. Aignan	23	14	0	3	6	61	00	13	26	
Blois	6	3	0	0	3	50	00	00	50	
Camp Hosp's	26	14	6	1	5	54	23	4	19	
Total	1904	614	227	482	581	32	12	25	31	

Fig. 1.—The above is a summary of patients seen in the Orthopedic Service at Savenay during September, 1918. In the vertical columns (condition upon arrival at Savenay) No. 1 indicates "No splint required"; No. 2, "Splint on and satisfactory"; No. 3, "Patient is wearing splint but correction of position or change of splint or both are required"; No. 4, "Condition requires operation, manipulative correction of deformity or application of splint." It will be seen that one-third of all patients and one-half of all those who required prevention and correction of deformity came to Savenay in faulty position or without splints or both. This situation as pointed out in the text was due to over-emphasis on wound treatment.

percentage of neglect was much higher. What was the reason? Chiefly that undue emphasis was being placed then, as now, upon the treatment of the wound. The bone injury or the joint lesion was often being allowed to drift into deformity and permanent disability while a relatively unimportant soft part wound was being given daily so-called antiseptic dressings of no particular value. These observations influenced me very largely in my conclusions later as to the harmfulness of frequent dressings. The injured parts, including fractures, were being disturbed,

and the wounds were being infected and reinfected by these maneuvers which we have since seen to be unnecessary.

In an effort to study the same problem from a different angle the American surgical forces adopted the plan that was employed by the British in 1918. We required our Surgical Services in Base Section No. 1 to submit monthly reports of all their sixty day cases. As indicated in the

Report of Base Hospital 27, Angers for the Month Ending Oct. 31, 1918.

Name	Number	Diagnosis	Days in Hospital	Reason
Althus, Edward	273709	Shell Concussion right knee	85	Difficulty in diagnosis, prospect of recovery Now "D".
Boyke, W. R.	39774	C. C. F. head of rt. humerus	100	Serious infection and poor general condition. ✓
Burlingham, N. J.	188277	Sprain of rt. ankle and Tendo-Achilles	70	Gradual recovery with good prognosis.
Chorengle, Chas.	563084	c. c. f. head of left humerus	75	Serious infection and poor general condition. ✓
Elkin, Jacob	106858	g. s. w. left knee and fractured patella	100	Serious infection with secondary abscesses. ✓
Good, Albert	269375	G. S. W. left knee	85	Prospect of good function. Now "D".
Holder, Purdy	304849	g. s. w. left shoulder	90	Held as ward orderly.
Kerr, F. W.	1245654	g. s. w. both thighs penetrating	105	In Hosp. Annex. Did not report for examination. ✓
Strautman, H. H.	.....	f. c. c. left tibia	135	(as above). ✓
Nordan, H. R.	1680143	g. s. w. rt. foot	61	(as above). ✓
Murray, Chas.	1941228	g. s. w. rt. knee	75	Serious infection with secondary abscesses. ✓
Jirvey, F. J.	Captain	f. c. c. left oscalcis	88	Serious infection with multiple abscesses. ✓
Stallings, L. T., Jr.	2nd Lt.	g. s. w. rt. knee	100	Serious infection Poor general condition. Now "D". ✓
Fillmyer, Jos.	1241718	g. s. w. rt. knee	75	Secondary abscess. Now "D" ✓

60 day cases

(Signed) E. W. Fiske, Capt. M. C.
Chief of Orthopedic Service.

Base Hospital No. 101, SOS, U. S. A. P. O. No. 701, S t, Nazaire, France. November 5, 1918.

55

Fig. 2.—Table of sixty-day cases from Base Hospital 27, Angers, France. Similar reports were obtained from Base Hospitals at Savenay, Nantes, and St. Nazaire. These reports were part of the effort to determine the efficiency of splinting and wound treatment in Base Section No. 1. It is to be observed that the sort of cases in which casts and splints were off for wound treatment were the long resident hospital cases.

copy of one such report (Fig. 2) the findings pointed in exactly the same direction. We were getting in our hospitals the same accumulation of chronic bone infected cases as the British had in 1917, with delays in healing due to the failure of our so-called antiseptic treatment. From

the A. E. F., moreover, thousands of our unhealed wounded had already been transported to home hospitals in the United States.

The conclusions arrived at as a result of these studies led later to the promulgation of an official order in regard to the care of these cases. This was prepared by the consultant in Orthopedic Surgery (the present writer) and issued by Col. Cooper, the Commanding Officer to all Surgical Departments in the Savenay Center and Base Section No. 1. This order was also approved by the Chief Consultant in Orthopedic Surgery, Col. Joel E. Goldthwaite, and sent by him to other hospitals and centers.

The introduction of this order is quoted to illustrate the manner in which it was attempted to meet the situation described:

Hq. Hospital Center, Savenay
28 November, 1918.

MEMO NO. 178

The following is published for the information and guidance of all concerned:

By direction of
Wibb E. Cooper,
Lt. Col. M. C., Commanding Officer
C. S. Adams,
1st. Lt. San. Cps.,
Adjutant.

Introductory

Certain data and conclusions resulting from a study of several thousand orthopedic cases at Savenay are submitted herewith as suggestions to the surgical services and the surgeons of this area. This information has been collected at the request of the Consultant in Orthopedic Surgery. The conclusions reached have been concurred in by the officers whose names are attached. It is believed that the safety and comfort of patients being prepared for and sent on convoys to the United States would be materially improved by an observance of the suggestions following:

The Treatment of Orthopedic Patients in Base Hospitals

The consideration involved in the treatment of war wounds in Base Hospitals must be made to include not only existing and imminent surgical pathology but ultimate position and function of injured parts as

well. It is these latter points which in both civil and military surgery, operators have been prone to overlook. A bleeding or an infected wound, especially if of considerable size, makes an immediate and urgent demand upon the surgeon's attention. There has been a tremendous accumulation of evidence in this war to prove, however, that wounds of whatever size and character heal better if all the parts involved are restored immediately to and adequately maintained in as nearly as possible normal anatomic relations. The different effect of such treatment upon the patient's ultimate career should be almost too obvious to require comment.

IT IS A FACT, HOWEVER, THAT NOT ONLY BECAUSE OF THE STRESS OF WAR CONDITIONS BUT BECAUSE OF THE FAILURE OF SURGEONS TO INTEREST THEMSELVES IN WHAT FOR CONVENIENCE MUST BE CALLED THE ORTHOPEDIC VIEWPOINT, MANY OF THESE PATIENTS IN BASE HOSPITALS FOR TREATMENT OR IN PREPARATION FOR CONVOY TO THE UNITED STATES HAVE NOT BEEN DEALT WITH ADEQUATELY IN THIS REGARD.

Following the evacuation of patients in convalescent detachments en route to the United States, reports came back that casts and splints were being disturbed on the transports or immediately upon arrival at home hospitals. An effort was made, therefore, to extend our influence for splinting and protection by the attachment of tags like the following to the apparatus in which we dismissed our departing patients.

Tag No. 1.—For Thomas Humerus Traction Splints:

> "The arm is to be kept securely bandaged into splint at all times. Only the bandage immediately over the wound is to be removed for dressings. The hand is to be kept in supination and dorsiflexed. The elbow is to be kept at or slightly beyond a right angle."

Tag No. 2.—For Thomas Femur Traction Splints:

> "Please do not release the traction or lift the leg out of the splint for dressings. Remove bandage only immediately over the wound and keep all others and the traction tight and neat."

Just before the Meuse-Argonne offensive we found ourselves at the Base Hospital short of assistance, short of typewriters, and short of splints and dressings. It was said that almost everything and every one had been ordered to the zone of advance. Permission was sought and obtained for the application of plaster of Paris casts in-

stead of splints only, as had been previously specified. At Savenay from September, 1918, until the following February, not less than one thousand casts a month were put on. Many of these patients were sent to the United States in their casts with better immobilization and no known ill effects. At that time all casts were provided with fenestra for daily dressings. I now regard that as a mistake; it is likely that many of these wounds would have been soundly healed upon or soon after arrival in the United States if a "nondressing" technic had been employed. As it was, there was a considerable improvement due to the immobilization of the injured members. The following letter is given in support of this view:

In reply refer to S. G. O.----------RBO:HML

War Department
Office of the Surgeon General
Washington

Nov. 30, 1918.

From: The Surgeon General, U. S. Army.
To: Major H. Winnett Orr, Base Hospital No. 8.
A. E. F., France. (Through Chief Surgeon.)
Subject: Returning Wounded.

1. I have had the opportunity to visit nearly all the hospitals in this country to which the wounded are returning, and it is extremely gratifying to find that the care and overhauling which the cases received at Base Hospital No. 8 is resulting in their returning to this country in most excellent condition. There are very few preventable deformities and the splinting is well done.

2. They are bearing their transport excellently. This, we realize, is largely due to the remarkable supervision which you and Abbott and your staff are giving the cases. The few cases of preventable deformities which we have found have, as far as we have been able to ascertain, not come under your supervision.

By direction of the Surgeon General:
R. B. Osgood,
Lt. Colonel, Medical Corps, U.S.A.

In replying
please refer 24 Dec., 1918,
to file No. C S 321623

2396

These descriptions of the situation in the hospital areas of Great Britain and France and of the remedial measures taken would hold at the present time for a large majority of the hospitals in the United States and also for the changes in wound treatment that ought to come about. The incorrect procedures in treatment leading to such conditions may be enumerated as follows:

First: Failure to place the injured or inflamed part in correct position, and failure to immobilize such parts in correct position during the period of healing.

Second: Inadequate drainage, whether the case be of either acute or chronic osteomyelitis or of a compound fracture. The customary incision and drainage tube treatment is not sufficient.

Third: The occurrence of accidental infection either at the time of operation or, which is more common, at the time of secondary dressings.

Fourth: Failure to provide against preventable deformity and disability arising from any or all of the above inadequacies of treatment.

The real lessons of the war would seem to arise from observations like these. But in spite of such experiences, conclusions disregarding them have been held out as the surgical lessons of the world war. Chief among these are (1) the efficacy of the Carrel-Dakin method for the treatment of infected wounds; (2) the necessity for establishing and maintaining mobilization of joints near or involved in compound fractures, and (3) the validity of primary and secondary closures of mechanically cleaned and disinfected wounds. Before insisting that none of these, but rather the disregard of them, constitutes the teaching of the war experience, I shall discuss them separately from my own point of view.

The Carrel-Dakin method consists in the use of Dakin's solution of sodium hypochlorite with the special technic devised by Dr. Carrel. It is an extremely difficult method to apply, requiring special training. From beginning to

end, the greatest care must be taken. The preparation of the wound must be undertaken with strictest aseptic precautions, insuring a thorough, methodical, mechanical disinfection of the wound and the removal of all foreign particles. The operation is cautious, gentle, and thorough, whether in a wound of the soft parts or of the bone. The surgeon must be careful to secure a thorough hemostasis.

When the wound has been thus prepared, tubes for carrying and discharging the Dakin fluid are placed in the wound so that the solution will reach every part. The manner in which these tubes are installed varies with the type of wound, but the result must be that the liquid reaches every part. In the care of the wounds, the strictest care is taken still to preserve asepsis. The Dakin solution is made to flow into the wound every two hours. The point is not to secure continuous irrigation, but to maintain an antiseptic of definite chemical concentration in constant contact with every portion of the wound.

This treatment is continued day and night. The wound is inspected once a day to make sure that the apparatus is working efficiently, and tests are made to determine the amount of infection present by a bacterial count. When three successive bacteriologic examinations have failed to reveal microbes, the wound is considered sterile. This should occur within from five to nine days. And after the wound has been found to be sterile, it may by further carefully aseptic procedure be closed by suture or elastic traction of some sort. Perfectly aseptic and satisfactory healing may be expected to follow.

The difficulties met in trying to employ this method, however, are both theoretical and practical, and are wellnigh insuperable. Dr. Keen in his book on the treatment of war wounds[1] lists three:

"1. that the treatment is likely to irritate the skin which must be protected by vaseline and by careful attention to

[1]Keen, W. W.: The Treatment of War Wounds, Philadelphia, 1917, W. B. Saunders Co., pp. 60-61.

the strength of the solution which is ineffective below 0.45 per cent and too irritating above 0.50 per cent;

"2. that the constant care required in daily inspection, flooding at two-hour intervals day and night, and the need of a new supply of fluid, which becomes inert within an hour, for every application is all too exacting and expensive, requiring a large staff of nurses; and

"3. that since a maximum of efficiency depends upon constantly keeping the solution in contact with all parts of the wound, basin-like cavities must be made in the wounds, and all dependent drainage must be avoided."

To these objections must be added others.

The first further objection, from the point of view of an orthopedic surgeon especially, is that the method interferes with rest. Bone injuries, especially if compound, must heal under conditions of proper position and of rest. To maintain proper position, casts and splints are used. While the Carrel-Dakin technic can be used with splints, it cannot be used effectively through windows in casts; there is practically always enough disturbance to destroy the correct position of healing parts. As for the principle of rest, the Carrel-Dakin method as usually practiced disregards that. Granted that gentleness is a guiding principle, nevertheless daily dressings and bihourly floodings of the wound are not conducive to rest.

A second objection embodies several others. Not only is the Carrel-Dakin method so complicated that surgeons using it should have special training, but with all precautions and in the best hospitals there is the possibility of secondary infection. In war hospitals this was especially true, but the possibility remains even when conditions are ideal. But further, the method in the hands of surgeons generally is much more liable to slip-ups than in the hands of those who worked it out. And the actual fact is, as one can observe in the hospitals of the country, that the method is being attempted by those who have not had special training and by those who are not following each

cautious step of the Carrel technic, and poor results ensue. Secondary infection and its consequences account for a large number of such failures. Disturbance, secondary infection—such is the frequent sequence.

The Carrel-Dakin method is to be objected to, further, because it is avowedly a refinement of the neoListerism which there is considerable reason for abandoning. Lister taught for years, as we have seen, that antiseptics are to create conditions favorable for natural healing; not to combat infection. But by this method the combat principle is followed, and the wound is not permitted to rest until infection is entirely gone. If there were any superiority in the new method, it would, of course, displace Lister's; but with its numerous other defects and liabilities to failure Carrel-Dakinism will have to be modified. The principles of primary asepsis and gentleness in handling tissues and so on are excellent, but the principle of combating infection in the wound, at the expense of other surgical fundamentals and with the danger of secondary infection, is wrong.

A modification of the Carrel-Dakin technic calling for the use of dichloramin-T, a synthetic chloramin not unlike the germicidal chloramin formed when the nascent chlorine of the hypochlorites comes in contact with the wound exudates, has been advanced. The method is much simpler, calling only for daily dressings, and it permits dependent drainage. It also saves in materials and in professional care. But the objections remain; daily dressings mean disturbance and the possibility of infection, they preclude the carrying out of other important surgical procedures. And the combat principle of destroying infection is still adhered to. These methods, found impracticable in war time, are unsound in peace time; the conditions of war may have intensified the failures, but the reasons for failure remain.

The second of the so-called lessons of the war was the conclusion that it is necessary to establish and maintain

mobilization of joints near or involved in compound fractures. This was most enthusiastically advocated by Dr. Charles Willems. In general, his teaching is that of early active mobilization of joint lesions as a principle to replace the old orthopedic teachings enunciated by Thomas and others. He says:

"If the articular wound is complicated by infection in addition to fracture, mobilization is still more strongly indicated, as it alone can give drainage, which is not perfect by reason of necessary limitation of the movements, but in all cases superior to that accompanying immobilization. Osteosynthesis (direct fixation of the fracture) in the midst of infection may facilitate the movements, but the plates will have to be removed secondarily.

"With a fractured knee it is evident that it is not a question of having the patient walk immediately, but mobilization in bed is possible, especially if one adds thereto a continuous extension which furnishes a certain fixation to the fragments, as well as a point of application for muscular action. This mixed method of treatment of articular wounds complicated by major fractures, by extension combined with active movements, gives functional results far superior to those obtained by other methods."[2]

The "certain fixation" referred to by Dr. Willems has always been very uncertain in the hands of those who endeavor to use the mobilization method. A mobilization method based upon the idea that motion is necessary to encourage drainage usually tends to bite off its own head; the drainage will be very profuse, and the reason will be that the irritation caused by mobilization and the practice of disturbing and removing splints and dressings will result in additional and secondary infection, producing more and more drainage.

But the more important difficulty of the method is its disregard of orthopedic principles. To teach, as Willems

[2]Willems, Charles: The Indications for Active Immediate Mobilization in the Treatment of Joint Injuries, Ann. Surg. 72: 426, 1920.

does, that a compound fracture of the femur into the knee joint, with a loss of one-third or more of the femoral condyle, may be treated by early and frequent motion of any kind, is to teach a method that results, for the most part, in loss of position of fragments, in secondary infection, in delayed healing, in almost certain deformity, and in more, rather than less, ultimate disability. And it is rather the case that primary débridement, protection against infection, and immobilization in correct position will induce earlier healing without deformity and with a minimum of disability. These difficulties, however, have not prevented a number of surgeons from urging that we "discard many of the traditional teachings of the past two decades" which may be right enough, and turn rather to the "more promising results by the later method of treatment, the requirements of which may best be summed up in the phrase first used by Willems, 'immediate voluntary active mobilization.'" The last may be questioned, as also may the assertion that "it is the duty of our Medical Schools to see that the Willems method is thoroughly taught as the one standard of treatment to follow."

Dr. Joseph A. Blake, whose war experience was very extensive, has also advocated more motion for fractures. All of this has led to no small amount of confusion, and considerable neglect of such cases. Dr. Blake says:

"The war has undoubtedly brought about a complete change in our ideas as to the treatment of fractures. The change came slowly and by a process of evolution. At first we were actually unaware as to what and where our changes in the customary treatment were leading us.

"Later, when a true conception of what we were arriving at dawned upon us and we deliberately discarded the older principles, we were able to make a greater and more satisfactory progress.

"Our experience during and since the war has convinced us that immobilization is not only unnecessary but actually prejudicial in the treatment of both gunshot and of many simple fractures.

"The first real inkling we received that immobilization of the fragments was not necessary was in 1914, in two cases of fracture of the humerus which were suspended in order to combat an enormous swelling of the forearm and hand. Although traction was imperfectly applied in these cases, they united in good position in what seemed to us an incredibly short time. This led to the general use of the suspension and traction treatment for fractures of the humerus, without the use of any splint for fixation and I believe the results of this treatment are unparalleled by those of any other."[3]

Dr. Blake puts his case very strongly, but that is not the lesson of the war as some of us got it. Moynihan has said: "Finally full emphasis must be laid on the paramount necessity for the complete immobilization of wounded parts at all times and on all occasions. So will one of the most powerful agencies making for infection and auto-inoculation be kept in check." And this sounds like sounder doctrine.

The principle of immobilization for injured parts is a fundamental feature of the writings of Hunter, Hilton, Hugh Owen Thomas, and others. Unfortunately, it is only from Thomas that we have inherited anything like efficient devices for carrying out this principle. One of the lessons of the Great War was that most of the splints in common use served perhaps to handicap the patient's movements to some extent but to immobilize the wounded part very little or not at all. Splinting in nearly all cases, moreover, was made secondary to wound treatment and splints were disturbed, and they are being disturbed today, upon the slightest provocation. Many had the same experience during the war and since, as Dr. R. B. Osgood who said, "plaster of Paris dressings with wide openings bridged by loops of metal or plaster offer the most perfect fixation and greatest comfort to the patient. These are employed in specially

[3]Blake, Joseph A.: The Application of the Methods Developed During the War to the Treatment of Fractures in Civil Life, New York State J. Med. 20: 357, Nov., 1920.

difficult and painful cases. Their disadvantages in an English general evacuating hospital, where there are often periods of great rush, are their time-consuming initial application and the practical certainty that they will be removed when they reach the home hospital."[4] This states the facts about splinting in the war. But despite this carelessness, we can carry out the principles of Hunter, Hilton, and Thomas if we will, nor is it even necessary now to use

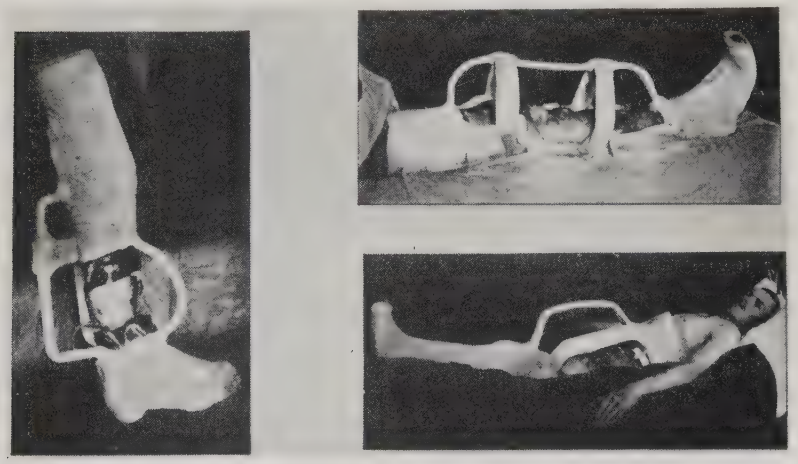

Fig. 3.—These illustrations have been taken from an article by Dr. Osgood and his associates in 1916. As indicated in the text, orthopedic surgeons were endeavoring to harmonize their methods of immobilization with the demands that were being made for daily or more frequent surgical dressings. During the war most of us made the effort to secure such immobilization as we could get with splints or casts with windows, but no casts or splints were permitted to interfere with irrigations, packs, daily dressings, etc. I contend now for the application of the principle of rest to the wound surface as well as to the injured part as a whole. Closed casts without windows are therefore regularly employed in our cases. (From Greenough, Osgood and Vincent, Boston M. & S. J. 174: 37, 1916.

the complicated casts described by Osgood; the troublesome openings requiring hoops are unnecessary when we dispense with frequent dressings and antiseptic irrigations.

As chairman of the Section of Orthopedic Surgery of the American Medical Association, I had this to say about splinting versus daily dressings in 1922:

[4]Osgood, R. B.: Correspondence, Am. J. Orthop. Surg. 15: 669, Sept., 1917.

"Our Surgeon General has said recently that the surgery of war consisted chiefly in 'harking back to first principles.' This comment may or may not do justice to our two years of effort in the military service. One might say that, if we really had successfully 'harked back' to first principles, we might feel fairly well satisfied with the achievement. After all, compliance with first principles is one of the things that surgeons have not done too well.

"My principal point, however, from the standpoint of an orthopedic surgeon, is that neither the Carrel-Dakin method nor any other kind of wound treatment should be permitted to interfere seriously with fundamental principles in the treatment of bone and joint injuries. These principles are, first, the immediate replacement, as nearly as possible, of injured parts in correct anatomic relationship, and second, the maintenance of immobilization ('enforced, uninterrupted and prolonged'—Hugh Owen Thomas) of such injured parts in proper relationship until healing occurs.

"In other words, wound treatment of whatever kind must not interfere with splinting in correct position. In the application of the Carrel-Dakin method, the disturbance of splints and the discarding of casts has been very common. It is my belief that splinting should come first in compound injuries. My attitude with regard to the Carrel-Dakin or any other forms of wound treatment, except drainage, in compound injuries is exactly the same; that is, they are secondary to correct splinting.

"This argument also brings up the old question as to splinting and stiff joints. To this my answer is that stiffness, whether of the joint itself, or of the adjacent soft parts, is due not to immobilization but to pathologic changes. Such changes are always due to irritation, inflammation, tissue destruction and scar formation. All of these are kept at a minimum, not by movement, but by rest. The minor stiffness that is inevitable to the minor injury can be broken up after healing occurs. The more serious

stiffness that results from more serious injury cannot be broken up either at the time by poor splinting or by force later on."[5]

Since these remarks were made, however, I have been able to carry my ideas more effectively into practice by the use of plaster of Paris casts wherever possible in the place of splints. This is now possible, of course, because of the use of the other principle of primary asepsis followed by very infrequent changes of dressings. The results attained in this way lead one to the conclusion that one of the real lessons of the war was that immobilization, not early mobilization, is the proper principle for the treatment of fractures where early union, early healing, and a minimum of deformity and disability are desired.

The validity of primary and secondary closure following a mechanical cleaning out of a wound and antisepsis or following extensive antiseptic treatment until a negative bacterial count is achieved is considered a third lesson of the war. The theory behind primary and secondary closure is not unlike that of the Carrel-Dakin treatment after the wound gives a negative result when tested for sepsis. The objections to such procedures are in part those made earlier.

A surgeon wishing to treat his patient by primary closure opens up the wound and investigates it for all foreign particles and all tissues that appear to be of no further use. He attempts, thus mechanically, to leave a clean wound. When he has completed his mechanical cleaning (débridement), the surgeon uses antiseptics, iodine or alcohol usually, for a final cleaning out of infection. Suture follows, and the hope that there will be no further infection. The fact that some surgeons are able to report a good percentage of favorable healings following the use of primary closure demonstrates the remarkable ability of the human body to combat and overcome infection; but the

[5]Orr, H. Winnett: The Fundamental Principles of Orthopedic, Reconstruction, and Industrial Surgery, J. A. M. A. 79: 255, July 22, 1922.

fact that there is so large a number of failures indicates that usually a large amount of potential infection is sewed up in the wound. It is this potential infection, growing in one of Nature's best culture media, that spreads throughout the wound to complicate the situation, to delay healing, to produce sinuses, and so on. This might be avoided by leaving the wound wide open to heal from the bottom up in such a way that infection is pushed out, rather than closed in, as healing progresses.

Secondary closure is the point of advantage chiefly claimed for the Carrel-Dakin treatment. This may not be done until the irrigated wound tests aseptic; but the difficulty is much the same. The bacteriologic test does not show whether all infection is gone; it may show that the solution is aseptic or even that the surface of the wound disinfected by the solution is free from sepsis, but there is no assurance that the wound is free from infection underneath the surface, as in sinuses. If there is infection there, closure will shut it in to grow and spread as before. And it may be said again, here, that the whole attempt to secure a wound that is clean enough to suture calls for the application of antiseptics, and the frequent change of dressings means the continual irritation of the wound and the continual liability to further infection from instruments, gloves, dressings, and so on. A "let alone" treatment would be better.

Moreover, it is common teaching and practice that if a primary or secondary suture "breaks down"—even in the case of a compound fracture—splints or casts are to be disturbed or taken off and the whole regimen of tubes, dressings, and packs is to be begun all over again and the wound treated without much regard for the position of the limb or the comfort of the patient.

Experience in the world war and since has convinced me that the three "lessons of the war" just discussed are lessons only in the sense that they may teach us what not to do. Superior as they may be in the hands of those who

worked out these methods or excellent as they may be when compared with what went before—or, for that matter, what is commonly being done now—these methods, nevertheless, do not succeed in general usage. And when they do not succeed, they are likely to cause failures that are worse than if the old ways of doing things had been followed instead. Because these are the facts, it may be claimed that we must turn elsewhere; and the operative technic and procedure of after-care which it is the purpose of this book to promulgate avoid most of these shortcomings. To prove that osteomyelitis in its several forms and compound fractures can be treated more simply and more successfully than heretofore is the burden of the succeeding chapters.

CHAPTER III

Osteomyelitis

In turning back to the work of Sir Joseph Lister we saw that our methods of antisepsis in the treatment of wounds are not only not what Lister taught, but not even as good as those he used. Our results are poorer, and our violations of certain surgical principles are to blame. The truth is, as we saw, that for the past forty years in this country we have not been using Listerism rightly so-called, but modifications of all kinds that have violated fundamentals of surgical practice.

Our observation of surgery in the world war revealed more strikingly an utter disregard not only of the proper use of antiseptics in dealing with infected wounds, but also of sound orthopedic procedures in the care of infected bone areas and fractures demanding immobilization and rest in proper anatomic position. Nor has our treatment of such cases improved noticeably since the war.

The care of osteomyelitis, both chronic and acute, and of compound fractures may be greatly improved if some attention is paid to the knowledge so long disregarded. The present chapter will deal with osteomyelitis; the following with compound fractures, since they are so large a part of the problem. The pathologic and bacteriologic aspects of the subject will not be discussed at length, as it is rather the demonstration of a method involving surgical principles and my special experience that is most pertinent here. It may be well, however, to review briefly the present state of knowledge regarding osteomyelitis.

No sharp distinction need be made in this discussion between acute and chronic osteomyelitis from the standpoint of treatment. Osteomyelitis may be considered to include all of those inflammatory conditions of bone and their

sequelae that arise out of acute hematogenous infection or direct infections resulting from injury. This, then, includes acute and chronic osteomyelitis as usually understood, as well as all fracture infections proceeding from within outward and from without inward. The gist of our knowledge regarding osteomyelitis in general, bone sepsis, is summed up by Dr. Gallie. Speaking of the general problems of infection following gunshot wounds he says:

"The shaft of a long bone consists of periosteum, compact and cancellous bone, and marrow. The periosteum is a fibrous membrane in which the blood vessels to the superficial layers of the bone ramify before entering the Haversian canals, and through which pass the large nutrient vessels on their way to the medullary cavity. It therefore follows that stripping of the periosteum will interfere more or less seriously with the circulation in the bone, depending on the size and the number of the blood vessels destroyed. When this occurs in an aseptic field, as in simple fractures, or during clean operations, or in compound fractures that do not become infected, no gross disturbance results, and it has been customary to suppose that no important pathologic change has occurred in the portion of bone so denuded of periosteum. That this is an error is witnessed by the fact that the rapidity of union of simple fractures is frequently inversely proportional to their severity; that union following operations on simple fractures, in which the periosteum at the ends of the fragments has been extensively reflected and plates or wires inserted, is often greatly delayed; and by the observations of Robertson and the writer that following the stripping of the periosteum over even small areas of the shafts of the bones of animals, coagulation of the blood in the Haversian canals occurs to a considerable depth, and the lacunar cells which derive their nutrition from these blood vessels become necrotic and slowly disappear. This superficial necrosis is by no means extensive and usually gives rise to no clinical symp-

toms, as the circulation rapidly becomes reestablished and the necrotic bone is quickly absorbed and replaced by normal bone."[1]

Circumstances are quite altered, however, the minute infection sets in. Dr. Gallie continues:

"Very different is the fate of similar necrotic areas of bone in the presence of sepsis. In this condition no reestablishment of the circulation takes place, and no invasion by osteoblasts from the neighboring living bone. If the drainage of pus is sufficiently free to allow the acute inflammation to subside and so terminate the spread of the destruction of the circulation, the residual septic irritation along the edges of the necrotic bone stimulates the osteoblasts in the surrounding living tissue to greatly increased activity, with the result that absorption of the living bone takes place until a zone is produced about the dead bone which is occupied only by granulation tissue, which, by a process of ulceration on the surface next the sequestrum, undergoes liquefaction, and so allows the latter to become free. Here it remains for months or years keeping up a constant irritation and by harboring a mild infection it usually prevents the healing of the sinus, or, if healing does occur, causes a recurring attack of more acute inflammation.

"Both in the case of aseptic necrosis produced by the disturbance of the periosteum and of septic necrosis produced by the spread of infection or by destruction of the circulation by mechanical means, coincident with the introduction of infection, changes of great importance occur on the surface of the necrosed area. On the surface of the bone, particularly in young animals, are many osteoblasts which were formerly supposed to belong anatomically to the periosteum, but which have been shown by Macewen, many other writers and ourselves, to be more properly classified as belonging to the bone. Whenever necrosis

[1]Gallie, W. E.: Chronic Septic Inflammation in Bone Following Gunshot Wound, J. Orthop. Surg. 1: 480, 1919.

occurs in the underlying bone, without the accompanying destruction of these cells, they are immediately stimulated to activity, as are all osteoblasts in the neighborhood of the necrotic tissue. Thus, when the periosteum has been stripped from an area of the shaft of the radius of a dog, under aseptic precautions, and either sutured back in its former position, or completely removed, these cells, which during such manipulation remain on the surface and in the irregularities of the surface of the bone, undergo rapid proliferation, and soon form a layer of cancellous tissue. In septic necrosis, if the infection is very virulent, or the evacuation of the pus long delayed, these superficial osteoblasts also undergo necrosis and no such new bone formation occurs. This is sometimes seen in cases of acute idiopathic osteomyelitis in children, the whole length of the shaft of the bone being destroyed, and no evidence of regeneration ever appearing. In the majority of cases, however, many of these cells survive, and after the acute inflammation has subsided, undergo rapid proliferation under the influence of the irritation of the underlying necrotic tissue and the mild infection. Some of the cells which are farthest removed from the source of irritation, that is, those that are most superficially placed, and which are therefore in the closest relation to the periosteum, begin to produce new bone, and before long the whole surface of the sequestrum, except opposite one or two cloacae through which drainage takes place, becomes covered with a thick layer of spongy bone called the involucrum. Between the involucrum and the sequestrum there persists the same zone filled with granulation tissue the inner surface of which is in a state of ulceration, as occurs at the line of demarcation. This appearance of a layer of new bone subjacent to and attached to the periosteum has been one of the strongest arguments in favor of the theory that the periosteum is osteogenetic.''[2]

[2] Gallie: Ibid. p. 481.

All of this takes place in the immediate neighborhood of the area of necrosis. In addition to these changes, however, Dr. Gallie continues:

" . . . . the whole of the neighboring bone within a radius of several inches may undergo inflammatory change. In the case of aseptic necrosis such as that produced by cutting out a piece of bone and then replacing it, this is slight, and cannot be detected beyond a distance of half an inch from the edge of the dead bone. But in osteomyelitis it may involve the whole of the remainder of the shaft, depending on the extent of the original necrosis. Thus, rarefying osteitis extending a long distance from the necrotic focus can be demonstrated, and the whole shaft over such areas becomes thickened by the deposit of spongy new bone. It is very evident, therefore, that mild septic infection is the greatest stimulant to bone repair. This is demonstrated clinically by the great masses of new bone that form in relation to septic compound fractures and by the spurs and irregular masses which develop at the ends of septic stumps.

"Another pathologic change of great importance occurs in these cases of chronic osteomyelitis, after the irritant has been removed. The osteoblasts which have been enormously increased in number throughout the whole of the inflamed area have hitherto been employed in the rarefaction of the neighboring bones. They now revert to their adult function of bone-production, with the result that previously soft cancellous and vascular bone becomes exceedingly hard, compact, and correspondingly anemic. Thus, a cavity left in the shaft of a bone after removal of the sequestra may gradually have its walls changed from soft cancellous bone to bone of flinty hardness and the change from vascularity to anemia in the walls has a great deal to do with the small tendency that such cavities have to heal. Similarly, after the evacuation of sequestra from septic nonunions, the ends of the bones may become so intensely sclerotic that there is little tendency to union after

any form of operation, the reason being that the outpouring of osteoblasts from the ends of the fragments is so slight that bony repair cannot successfully bridge the gap, and the space fills again with fibrous tissue.

"The rôle of the marrow in the growth and repair of bone seems to be much the same as that of the periosteum. It does not contain many osteoblasts, these being confined to the layer of cells known as the endosteum, which lines the irregularities of the medullary surface. Its function, considered surgically consists in acting as a medium for the distribution of the blood vessels to the Haversian canals of the deep portions of the bone. It follows therefore that damage to the circulation in the marrow will produce changes in the deep layers of the bone similar to those already described in the subperiosteal layers, after destruction of the circulation in this locality. We have recently been able to demonstrate such changes in a case of acute hemorrhagic infantile scurvy in which the stripping of the periosteum of the tibia involved its nutrient arteries. Sections of the bone made three months afterwards showed the deep layers of the bone, as well as the superficial, to be necrotic, the cells having disappeared from the lacunae, and the bone undergoing absorption and replacement by cells which had invaded it along with blood vessels from neighboring living tissue.

"Clinically we see a demonstration of these fundamentals in the character of the sequestra which result from various types of wounds. Thus, in compound fractures and in amputations in which there has been acute infection, more particularly if drainage has not been provided early, one is apt to find sequestra form at the expense of the medullary surface of the shaft, indicating the spread of infection and destruction of the circulation in the marrow. All are familiar with the cone-like, tapering sequestra that can sometimes be pulled out of the ends of the septic stumps. On the other hand, in those cases in which stripping of the periosteum has been a feature of the condition,

such as in acute idiopathic osteomyelitis, or in operations on the long bones in which the periosteum has been freely reflected and sepsis has been present or has supervened, the sequestra always consist of flakes separating from the periosteal surface of the bone. As in the case of the tubular sequestra which often separate from the medullary surface of stumps that have been septic, we are quite familiar with the circular sequestra which are pulled off the outer surface of the ends of bones from which the periosteoum has been reflected during the operation."[3]

Speaking of the methods of treatment in use during the world war and up until the time of writing, Dr. Gallie says:

"The difficulty always has been that in spite of the treatment, a high percentage of the cases did not heal, or if they did heal, repeatedly broke down, leaving sinuses communicating with cavities in the interior of the bones. Sometimes these sinuses have persisted for years with a constant slight purulent discharge and other signs of deep seated inflammation. At other times they have healed spontaneously, only to recur years afterwards, following the onset of symptoms of acute osteomyelitis."[4]

These comments apply with equal force to all other forms of chronic osteomyelitis as well as to those caused by war injuries.

Dr. Gallie also directs our attention to the customary, often inadequate, surgical treatment:

"The usual primary treatment of osteomyelitis has consisted simply of incision and drainage. After the lapse of three or four months, by which time any necrosed bone has become separated, the sinus is enlarged, the sequestrum removed, and the operation completed by curetting the cavity and the sinus and packing the wound with gauze."[5]

[3]Gallie: Ibid. pp. 483-4.
[4]Gallie: Ibid. p. 470.
[5]Gallie: Ibid. p. 470.

In many cases, however, as the specialist often sees, this inadequate drainage operation is followed by a long septic period with daily dressings which may be not too severe, during which, if the patient survives, there will appear a sequestrum formation, septic metastasis, secondary bone and joint lesions, multiple sinuses, contracture deformity, and the other disagreeable complications with which we are so familiar. And with children, especially, this delay for the formation of sequestrum before doing a radical—drainage—operation has often led to serious results. Many surgeons have even delayed the necessary primary drainage of the acute bone abscess, while others have done an inadequate primary drainage and then permitted the patient to endure a long subacute or chronic septic course, local and general, so that sequestrum and involucrum formation might give some security to a badly damaged limb. The consequent lowering of the patient's general condition during such a period of waiting has often been serious or even fatal.

The paragraphs quoted from Dr. Gallie summarize excellently the problems in osteomyelitis, but his criticism of its treatment only scratches the surface. And if we are to do justice to our patients, we shall have to make drastic changes in our methods of treating them. In acute osteomyelitis, as we commonly see it, there is a failure first of all to make a prompt and early diagnosis. Such patients are frequently treated for rheumatism, for arthritis, or even for typhoid fever or some other acute febrile condition for days or weeks before the true condition is realized. After the correct diagnosis is made comes usually our second mistake—an inadequate incision for drainage. Not uncommonly the primary incision is made into a knee, elbow, or ankle joint; and while some pus is often evacuated in this manner, the osteomyelitic focus is seldom opened up, so that progressive infection and death of bone in the infected area result. In the third place, even after the diagnosis has eliminated rheumatism and the like, such pa-

tients are frequently treated for cellulitis, tenosynovitis, or some other supposedly more superficial infection than osteomyelitis. In such cases multiple incisions are often made extending from the foot to the knee or from the hand to the shoulder. Extensive death of bone, septicemia, or even the death of the patient have been observed where such extensive incisions have been made without any drainage of the primary focus in the bone.

If the patient survives the acute attack, whether or not the infected area has been drained, he passes into the condition we call chronic osteomyelitis. It has been the common teaching that a primary simple incision is sufficient treatment for such cases and that localized death of bone or sequestration and the attempt at repair around this dead bone or involucrum formation should be awaited before the attempt is made to drain thoroughly. And this constitutes another error in the treatment of osteomyelitis.

It should not be considered necessary to await the subsidence of the acute condition. Sufficient drainage in the first place will usually prevent these severe local conditions and also general septicemia, sometimes saving the life of the patient. If the patient is first seen in the chronic condition, however, and after certain areas of sequestrum have formed, then drainage must include the removal of sequestrum in order to make a cavity that will heal without covering over septic pockets, fragments of dead bone, and the like.

Another great mistake in the treatment of such cases is the failure to prevent the secondary and mixed infection arising from injudicious, unnecessary, and unsurgical secondary dressings. Such dressings are made chiefly to satisfy curiosity about what is occurring underneath the original dressing, and to satisfy those who have an urge to be continually doing something about a wound. And what usually follows is the introduction of new and mixed infections to complicate matters where the patient had already begun to get rid of what infection he had. Aseptic

dressings in the first place will make for a minimum of infection, and this the patient can combat himself; subsequent dressings only serve to disturb natural processes of healing and to cause new infection.

Facing the difficulties encountered in the treatment of osteomyelitis, I have outlined a method which aims, in conformity to fundamental surgical principles both as regards the care of infected bones and joints and the care of wounds surrounding them, to provide: first, immediate adequate drainage at whatever stage the osteomyelitis is encountered; second, the maintenance at rest of inflamed parts by the application of a plaster of Paris cast, aided if necessary by ice tongs or other methods of skeletal fixation; third, wide open drainage by means of a sterile vaseline pack; fourth, primary asepsis or antisepsis avoiding the use of irritating antiseptics in the wound; fifth, postoperative care emphasizing rest *without antiseptic dressings* which usually increase and complicate infection, and sixth, the maintenance of all injured parts, bones and soft parts, in their correct anatomic position during the entire period of healing. This procedure, which is called the "Orr method," is the result of observations regarding the bad effects of contemporary "Listerism," the mistakes of our wartime care of injuries, and the errors in civil practice since the war. It will be well to delay a full description of this method, however, in order to present cases and examples of the present day treatment of osteomyelitis and to criticize them in the light of the broader experience which has resulted in the promulgation of the Orr method. It may be said that the chief defects, not already mentioned, include timidity in operating, overboldness in operating, failure to drain adequately, inability to recognize acute bone abscesses, and too many disturbances during the patient's attempt at healing.

Early diagnosis in acute osteomyelitis is an important factor in the treatment. Because of failure to recognize an acute bone abscess, especially in children, correct treat-

ment (i.e., adequate drainage) has often been deferred with serious consequences to the patient. Very often, however, there has been failure to provide drainage on account of timidity in regard to opening into an acutely infected bone. This attitude is reflected in the following quotation which reveals the current teaching in regard to these conditions:

"1. An early and concise diagnosis and immediate surgical treatment is of the greatest importance.

"2. The operation should invariably consist in splitting the periosteum for a distance of from 2 to 5 cm. beyond the area of pain upon pressure in the bone in each direction.

"3. The periosteum should be loosened from the bone for a distance of from 1 to 2 cm. on each side of the incision.

"4. In extremely severe cases these should be the extent of the primary operation.

"5. In less severe cases ultimate healing can be hastened by carefully opening the medullary canal at the point previously located because of pain upon pressure.

"6. Care should be employed to prevent traumatizing the tissue by rough chiselling.

"7. Moist hot antiseptic dressings with fixation of the extremity and the use of electric light treatment increases the comfort and facilitates healing.

"8. The shaft of a long bone should never be removed until a good involucrum is formed.

"9. In late cases or in secondary operations upon patients treated as above in the acute stage, every particle of dead tissue must be removed.

"10. At this operation some definite plan must be carried out to facilitate closing the defect.

"11. Skin grafting is of great value in many cases.

"12. Local foci of infection, such as abscesses of tonsils or teeth or sinuses, should invariably be eliminated at once upon undertaking the treatment of patients suffering from osteomyelitis.[6]"

[6]Ochsner, A. J., and Crile, D. W.: Clinical Consideration of Osteomyelitis, Surg. Gynec. Obst. 31: 275, Sept., 1920.

Upon a much earlier occasion, however, Dr. Murphy spoke emphatically for the early adequate drainage of such an acute bone infection. "Osteomyelitis is in reality a condition like a gangrenous appendix in the end of the bone. Early and radical operation is indicated. A delay of forty-eight hours is not only extremely serious but often fatal."[7]

Some authors have been more radical in their advice even for the primary operation. The following is quoted only to criticize, as the operative procedure suggested has proved too radical even for regular employment when the patient with an acute attack has carried over into the less virulent chronic conditions:

"Trauma still plays a considerable part in predisposing to the disease, while the exciting cause is one of the organisms of suppuration, principally Staphylococcus pyogenes aureus. Whether the starting point of the lesion is in the cortex, the medullary cavity, the end of the bone, or the epiphysis, success in treatment depends on opening up the original focus of infection and the removal of all diseased bone at the primary operation, even if that removal entails a more or less complete resection or excision of the shaft, should be emphasized. When the condition of the patient warrants it at the primary operation, such radical treatment greatly shortens the time of convalescence, prevents further destruction of the bone, lessens the subsequent number of operations, and reduces the mortality."[8]

Resection of any considerable portions of infected bone has usually been followed by unsatisfactory results. Bauman and Campbell in 1926 again proposed a more general use of the procedure for the radical cure of osteomyelitis. To me their own report seems sufficient to condemn the method:

[7]Murphy, John B.: Discussions of Operative Treatment of Fractures, J. A. M. A. 59: 303, July 27, 1912.

[8]LeConte, Robert G.: Acute Inflammation of Long Bones, J. A. M. A. 59: 301, July 27, 1912.

CASE 1.—After three operations in three months healing and regeneration of the bone progressed with final cessation of the discharge about 18 months later. Two years after the operation the femur was found to be much bowed anteriorly probably because traction was not used.

CASE 2.—The femur and tibia have reformed strikingly although there is a two-inch shortening of the left leg.

CASE 3.—The right ulna partially is absent, the left humerus is solid but irregular. . . . There is slightly exaggerated mobility of the right elbow and wrist and the left foot is in slight valgus.

CASE 4.—Progress seemed good until ten months after the operation when a fracture was noticed, there being no history of violence. . . . Four years later he has a firm bone with one and one-half inch shortening and moderate deformity.

CASE 5.—There is ankylosis of the hip with one and three-fourths inches of shortening.

CASE 6.—[Good results in three years.]

CASE 7.—Two years after the resection of the tibia the patient returned complaining of pain in the leg and the x-ray showed an ununited fracture of the regenerated portion of the bone.

CASE 8.—Ten months after the resection the patient fell and broke the regenerated portion of the bone with opening of the old sinus.

CASE 9.—[Three years, numerous operations.]

CASE 10.—[Case very "Stormy." Femur three inches short.]

CASE 11.—Syphilis positive. Failure to regenerate tibia.

CASE 12.—[Nonsuppurative osteomyelitis.]

CASE 13.—[Some deformity.]

CASE 14.—Nonunion—patient refused amputation.

CASE 15.—[Fair result.]

CASE 16.—Resection tibia. Dakin and salt solution for several months. Secondary abscess humerus after two months. Healed in six months.[9]

Bauman had four cases of incomplete regeneration and four fractures healing with serious disability. It seems clear, then, that this is a method of limited application and a large percentage of poor results. And it seems evident that these results follow, because methods of postoperative care are used which militate strongly against sound and rapid healing and recovery with the injured parts in cor-

[9]Bauman, George T., and Campbell, Horace C.: Resection of Long Bones for Chronic Osteomyelitis, Surg. Gynec. Obst. 42: 114-123, Jan., 1926.

rect and useful position. It is a fair conclusion that Bauman's operative method is too radical for general adoption and that his after-care is open to all of the objections listed above.

The fact that surgery along with other branches of knowledge must continue to learn lessons once taught and forgotten is indicated in the antithetical quotations which follow. The second, of course, is the more nearly correct. The first:

"Excision of the femur for gunshot fracture was never a popular method of treatment and, like excision of the humerus, it is no longer advocated by military surgeons. It proved to be a very fatal procedure in our Civil War. Otis records 175 excisions of the femur for gunshot fracture. Ninety-one of these were done in the primary stages with a mortality of 76.4 per cent, 38 cases in the intermediate stage with a mortality of 81.2 per cent; and 18 in the secondary stage with a mortality of 16.6 per cent. All the cases for which primary excisions were once resorted to are now amenable to treatment by conservation."[10]

We might have learned our lesson thirty years ago. The second selection is headed "suppurative osteomyelitis," and reads:

"When suppurative inflammation occurs in the medullary cavity of the bones, it is apt to cause extensive destruction of the bone and intense septic infection, unless the pus finds an early exit through the compact layer of bone. As soon as a diagnosis can be made, the canal of the bone should be freely opened by chisel or gouge and the softened and diseased marrow removed with a curette. The cavity should then be as thoroughly disinfected as is possible. This course accomplishes in whole or part the following results:

"1. It diminishes pain.

"2. It lessens destructive necrosis of the bone.

[10]La Garde, L. A.: Gunshot Injuries. New York, 1916, William Wood & Co., pp. 393-4.

"3. It lessens the danger of fatal septicemia.

"4. It enables the surgeon to remove much infected tissues, and thus expedites recovery.

"The preliminary preparation is made in the manner usual for other operations. After the diseased medullary tissue has been removed, the cavity should be washed out for five or ten minutes with a 1 per cent solution of lysol, and then swabbed out with 95 per cent carbolic acid on a gauze pledget held in forceps and immediately followed by an application of alcohol. The stronger antiseptic solutions, like mercuric chloride or iodide, should not be used to irrigate the cavity, as from the porous nature of the bone marrow a dangerous absorption might occur. The same objection holds good against packing a large cavity with iodoform gauze, as is often advised. Either plain sterile gauze or formalin gauze should be used, and the wound covered by a copious absorbent dressing and placed on a splint. The wound should be dressed daily, and, if the temperature still remains high, the dry dressings may be changed to the dressings saturated with a 1 per cent solution of aluminum acetate.

"After the acute process has subsided, or in chronic cases in which the pus has found an exit for itself and is followed by necrosis of the bone, the sequestrum and all diseased medullary tissue should be removed, the cavity disinfected in the manner indicated, and then packed with decalcified bone chips as advised by Dr. Senn. The bone chips are strips of the compact tissue of bone from which the lime salts have been removed, and then the chips are preserved in an alcoholic solution of bichloride of mercury of a strength of 1 to 500. They resemble strips of cartilage, and are probably absorbed in the same manner as catgut. They serve to obliterate the cavity in the bone and act as a scaffolding for the formation of new bone.

"The strips should be soaked in sterile water for a short time to remove the solution with which they are saturated. They are then packed in the medullary cavity, level with

the surface of the bone. If the periosteum has not been destroyed, it should be stitched with catgut and the overlying soft tissues closed without drainage, and the ordinary aseptic dressing should be applied.

"Dr. Senn has obtained unexpected results by this method, and the author has seen a case in which the removal of two-thirds of the medullary tissue of the femur was followed by primary union and no marked change in the contour of the limb.

"Should signs of infection occur, an anesthetic should be given, the wound reopened, the bone chips removed, and the cavity cleansed as before described. The cavity may then be allowed to fill in by granulation, or a second attempt at implantation of bone chips be made after suppuration has ceased."[11]

Of course most of the above recommendations about after-treatment are wrong; but the importance of primary drainage and asepsis has been noted, and the results are better.

This discussion is enough to show how, according to my belief, osteomyelitis should not be treated. The development of a different technic has met with many obstacles, and changes have had to be made as experience directed. One of my early attempts to formulate a different method is indicated in the following paragraphs, to which are added a series of cases designed to show further developments in the new technic:

1. In most bone infections the patient begins with an infection by a single organism. This becomes a mixed infection as a result of the commonly employed methods of treatment—operation or dressings.

2. In ordinary practice the fundamental surgical principles of aseptic operation and dressings, wound protection, and rest for the affected part by proper splinting have been disregarded in order to carry out the methods of so-called "chemical sterilization."

[11]Palmer, Henry B.: Surgical Asepsis, Philadelphia, 1903, F. A. Davis Co., p. 150.

3. In the mixed infections that follow such methods, healing is very much delayed or not obtained at all, and deformity and disability of the affected part are the rule.

4. Healing of such conditions, when obtained in the past, has usually come about in such a way as to suggest that it is the result of the patient's having evacuated his infected area and having overcome his infection; rather than of the operation, irrigation, dressings, etc., that were employed.

5. A patient who survives any acute infection may be assumed to have developed a certain measure of self-protection (immunization) which he can use towards recovery if he is not overwhelmed by the existing or added (mixed) infection.

6. The points to be observed in treatment would therefore appear to be: (a) drainage; (b) removal of dead tissue; (c) protection of the infected area against reinfection or mixed infection; (d) to enable patient to make the most efficient natural resistance to his infection, and (e) to have the patient recover with all the affected parts and other parts in the vicinity in such relation to each other as will make for avoidance of deformity, a minimum of disability, and therefore the best possible function.

7. Many of these points have been rather regularly disregarded. It is my opinion that they must all be carefully considered in every case. For example, in a recent case a woman of forty was seen with an osteomyelitis of the wrist. She was found in bed with an extremely swollen hand, wrist, and arm, and in great pain after two months of previous treatment. The hand and fingers were straight and swollen, and rested on a pillow without other support. The wrist was slightly flexed, and the hand pronated. There were two small punctures on the back of the wrist. The osteomyelitic cavity had not been drained. In this case the greater part of the carpus was resected. The hand was dorsiflexed on the wrist, a plaster splint was

put on to the shoulder, with the hand supinated and the elbow at a right angle. This patient made a good recovery in about eight weeks, and has resumed a manual occupation.

Many of the patients coming to any specialist are those whom others have attempted to cure, but have failed. The condition in which the patient in the following case was first seen indicates what our present methods lead to; only a radical operation of the most extensive sort saved the patient's life:

Case 1.—This boy, T. T., was seen after one month's illness in the hospital. He was in a desperate condition, with an extensive septic involvement of the entire leg extending to the knee. There was a tremendous swelling of the limb as high as the hip, and the boy was acutely septic. During the month since the beginning of the attack various incisions had been made from the upper end of the tibia down to and including the foot. No opening had been made into the tibia itself, though several sinuses leading into the tibia could now be found. The shaft of the tibia was dead from one epiphyseal line to the other and there was involvement of the astragalus and os calcis as well as of the ankle joint. No metastatic foci had developed, though the patient was markedly septicemic.

It was necessary to decide the question of amputation, which was promptly advised against, as it was evident that amputation would cost the boy his life.

An extensive drainage operation for the foot and entire leg was done the same day. Large windows were made in the bony structure of the tarsus and in the upper and lower ends of the tibia. A large sequestrum in the tibia was not removed until later. The wounds were packed wide open with vaseline gauze and the entire limb was put in a plaster cast. The limb was put in suspension and traction at once. (It is desirable to employ suspension in a Balkan frame and traction by means of weight and pulley for all patients with lower extremity osteomyelitis when it is undesirable to use a double plaster spica or a body cast. With small children or patients difficult to control the double spica is to be preferred. In the upper extremity in children it is desirable to use the body and arm cast with the arm in abduction, the elbow flexed, and the hand supinated. The ordinary aeroplane splint or recumbency with the Blake suspension device may be used.)

At the time of operation the entire leg was full of pus. For the first few weeks drainage was very profuse; at the same time dressings were very infrequent and the packs were not removed oftener than at intervals of from two to four weeks. This boy was slow in recovering, but left the hospital in about ten weeks and after that time was dressed about once a month. He had four or five changes of cast then wore a caliper splint for about six months.

The photograph (Fig. 4) shows the condition at the end of twelve months. Both leg and tarsus finally healed at the end of about eighteen months and have remained so. Attention is called to the range of motion in the knee which is within a few degrees of normal, this in spite of eight months in a plaster cast.

The boy is now in school and has a useful limb. An additional photograph shows the condition at the end of two years.

Fig. 4.—Patient T. T., showing condition of leg at the end of one year. Very extreme case.

The following are the notes of a typical severe case treated by my method at about the same time. Here is a patient also who had drainage enough to save her life but not enough drainage in the course of four months to start her on the road to recovery.

Case 2.—This patient, W. C., was brought to the hospital on July 14, 1924, with an osteomyelitis of the tibia involving the knee joint. She had had the primary acute attack four months earlier and had been drained by incision

Fig. 5.—The condition of the limb, shown in Fig. 4, at the end of two years. There has been no activity of the infection for one year.

on several occasions. There were five open incisions about the upper part of the leg and the knee at the time of her arrival. The abscess in the interior of the tibia, however, had not been drained. She was extremely septic and

was brought in for amputation with the thought that that was necessary as a life-saving measure. It was at once apparent that the entire upper half of the tibia and the knee joint were full of pus.

Drainage was advised rather than amputation, and the operation was performed the same day. A large sequestrum was found in the interior of the upper half of the bone, and the abscess cavity was found to have ruptured into the knee joint. The entire cavity including the opening into the knee was cleaned out and packed with vaseline gauze, and a double spica cast was put on. The cast was changed and a new dressing was done about six weeks later on August 29. Eight weeks after that the second spica was removed and a long leg cast was put on.

Fig. 6.—W. C., aged fourteen years, operated upon July, 1924, for osteomyelitis of the tibia of four months' duration. Patient was very sick, with knee joint involvement and septicemia. There had been numerous incisions about the knee and leg before admission to the Hospital, but there was still imperfect drainage. After operation and care by my method final healing was delayed, and there was a persistent sinus for several months. At the original operation the entire upper end of the tibia as well as the knee joint had been widely opened and packed full of vaseline gauze in the manner previously described. When the sinus failed to heal, the wound was again opened into the knee joint, and it was found that a piece of crucial ligament was acting in the same manner as a bony sequestrum. When this was removed, the wound proceeded to heal without very much delay. Final result was sound healing with a useful limb but a stiff knee. It is intended that this knee shall be given motion by an arthroplasty.

The patient was kept in cast and dressed at intervals of about four weeks (she lived two hundred miles away and reported once a month for inspection) until April, 1925, at which time a caliper splint was put on. In May, 1927, the sinus had not entirely healed. There was no evidence on the x-ray of a further sequestrum, and it was decided to explore the knee for the cause

of the persistent sinus. This was found to be a sloughing portion of the posterior crucial ligament which had remained as a sort of sequestrum with a small abscess cavity of its own. This cavity was again packed wide open with vaseline gauze and has since soundly healed and remained well.

This case is reported principally to call attention to the somewhat unusual complication. It must be observed, however, that a very sick patient, with knee joint involvement, has recovered not only without losing her limb, but without secondary abscesses, contracture deformity, or any of the other complications to which we are quite accustomed in such cases.

It may be observed, as we consider cases of this sort, that we have tended to underestimate the possibilities of successful results with such patients. The usual teaching has been that in acute osteomyelitis there is an unusually virulent type of infection; that such cases may be "malignant" or "fulminating" and the like. To employ such terms after the death of a patient with acute osteomyelitis, for example, is in many cases only to cover up defects of diagnosis and treatment. It has been observed that many cases cease to be "fulminating" very promptly upon thorough drainage and immobilization of the inflamed parts in plaster of Paris. The following is such a case:

Case 3.—N. H., aged nineteen. This boy came to the hospital with a greatly swollen and painful right shoulder. The shoulder had been injured in a basket ball game a week before. During the week he had visited an osteopath on three occasions and had had three very painful manipulations with an increase in pain and disability after each treatment. Upon arrival at the hospital he had a moderate temperature (about 102°) and a white blood cell count of thirty-four thousand. The shoulder was so badly swollen that there was some difficulty in deciding whether to explore the humerus or the scapula. An incision behind the deltoid muscle led at once to a large abscess cavity, with the periosteum completely stripped off from the upper one-third of the humerus. An opening into the humerus just distal to the epiphyseal line released a considerable amount of thick yellow pus from the interior of the bone.

The humerus was opened for a distance of about three inches, and the entire wound was packed open with vaseline gauze. A body and arm cast was put on not without some difficulty, with the arm in sixty degrees abduction, elbow flexed, and the hand supinated and dorsiflexed. Within a few days secondary soft part abscesses appeared and had to be opened at the

elbow on the same arm, over the scapula, over the ulna on the left arm, and over the fibula on the left leg. For all of these reasons the septicemia was slow in subsiding; the arm drainage opening discharged freely through the top of the cast, but the wound was dressed infrequently, and no later secondary complications developed. On account of the severe and extensive infection in the shoulder and arm the patient was kept in plaster and aeroplane splint for seven months. At the end of one year he was able to resume University work with an arm about 70 per cent functional. There has been no recurrency of the infection.

My method was at first worked out with the chronic osteomyelitis patient in mind. And in fact, all of the early cases were treated most carefully and conservatively so that accidents should not occur that might suggest liability for damage due to not having conformed to usual methods of practice. There has been some precedent, for example, for the primary closure of low grade infections and bone lesions; and in a few of our early cases we undertook primary and secondary closures in these cases and it is when such attempts at primary and secondary closure have failed that the new method of open drainage and rest have proved of greatest value in escaping a difficult situation. For example:

Case 4.—A. S., age seven, came to the hospital with a bruised knee of some months standing, and there had been a history of increasing pain, disability, and swelling at the ankle. There was marked tenderness about the lower end of the tibia, especially on the fibular side, and there was enough swelling so that the entire ankle pitted upon pressure.

The little girl had a marked limp, and she was restless at night. The x-ray showed a bone abscess at the lower and outer portion of the tibia but no sequestrum. The x-ray appearance was like that of Brodie's abscess, but the symptoms might have been called subacute.

An incision was made down upon the front of the lower end of the tibia, and a thin-walled abscess cavity was easily broken into. The contents of the cavity were not typically suppurative. The laboratory cultures indicated no growth.

It was thought that it might be safe to close this wound primarily; this was done and a long leg cast was put on. There were no marked postoperative symptoms either as to pain or temperature, but the child was not really relieved and the pain in some measure continued. One month later the wound was dressed, and it was found that there was some drainage. The wound had to some extent broken down. At this time the wound and the surrounding area was sterilized, and the wound was packed with sterile vaseline gauze down into the bone cavity. The window in the cast through which the dress-

ing had been done was now closed with additional plaster and no further dressings were done for another month. Treated in this way final healing occurred in five months. After the third month a posterior iron was worn instead of the cast. There has been no return of symptoms of any kind since the first postoperative dressing. No antiseptic treatment was used except that tincture of iodine was employed at each of the five dressings. There is no lameness or limitation of motion at the present time.

A criticism of the Orr method has sometimes been that there is no particular credit in operating upon and curing the subacute or chronic patient who has successfully weathered the storm of the acute attack. There is, of course, some truth in that statement, and undoubtedly many surgeons get rather regular good results by the employment of good operative and dressing methods. One of my contentions, however, is that even if there were no shortening of the convalescent period by my method, though there is such a shortening in many cases, and even if the number and kind of cures were no higher (which is not the case), the saving in suffering to the patient, labor for the nurses and doctors, material for hospitals, the prevention of ultimate deformity and disability all unite to recommend this method over those in common use.

The following is an illustration of such a situation in which the enforced saving in hospital expense and necessary simplicity in after-care did not interfere with the permanent result.

Case 5.—M. K., aged sixteen years, had an acute attack of osteomyelitis in the lower end of the left femur in the last week of October, 1923. She was at first supposed to be having an attack of acute rheumatism but the trouble was later diagnosed as arthritis of the knee, and several attempts were made to aspirate the contents of the knee. She was brought to me on December 30, 1923, and was operated upon the same day. A large window was made into the medulla on the outer and *ventral side of the femur* just above the external condyle, which is the ideal place for draining the lower end of the femur. Not only the tissues about the femur, but the entire medulla and the epiphysis were found filled with pus. This patient was not very septic and her postoperative course was uneventful. The wound healed rather slowly; dressings were done about every two to four weeks. There was a good deal of odor, but there were no inflammatory complications of any kind. The patient left the hospital in the third week and in April was able to return to her home some two hundred miles away. There was still a small

sinus when she was discharged, but this healed in about two months and has remained so. There is a little contracture deformity of the knee and foot at the present time, but not enough to cause any disability for ordinary school and household duties.

There are those patients also who, after years of daily dressings and disability, are the most anxious to obtain relief on any terms. For such patients also this method has given us not only the means of obtaining a cure, but also, because of its simplicity, relief from several operations and countless dressings. Patients who have weathered many an operation and all their consequent dressings are not displeased to discover that, by this method, the single operation will be followed by dressings only at intervals of from two to six weeks, that they will have to remain in the hospital a matter of from three to five days after the operation, and, not the least important, that the prospect of a permanent cure is fairly certain.

The following case is selected for citation here because it is an example of those cases "that will not heal," and because, although I performed the operation according to my method, the after-care was left to others:

Case 6.—Miss E., aged sixteen. This young lady was seen at the Swedish Hospital in Seattle on June 23, 1927. She had had several previous operations for chronic osteomyelitis in the lower third of the right femur. There was a discharging sinus on the inner side of the thigh just above and behind the internal femoral condyle. There was extensive scarring on both sides of the lower thigh. Although the external opening is usually preferred, the abscess and a small sequestrum in this case were approached directly through the old scar on the inner side of the thigh. The sinus leading into the medullary cavity through a wall of greatly thickened involucrum was opened widely; the entire cavity including the bone was cleaned out and packed with vaseline gauze. A double leg cast was put on with crossbar (we frequently use this instead of double or single spica) and the patient was put to bed with twenty pounds of weight from the crossbar. The wound in this case was dressed at intervals of from three to six weeks and was soundly healed in about five months. I had occasion to visit Seattle again in February, 1928 (eight months after operation) and found the patient well and happy.

Everything considered, however, the results obtained in cases of chronic osteomyelitis of the kinds just described has proved to be least important of the effects of this

method of treatment. Many interesting achievements in the field of compound fractures will be described in the next chapter. The most striking cases have been those of true acute hematogenous osteomyelitis in which thorough drainage, even rather late in the acute attack, wide open pack, and prolonged immobilization have yielded immediate and gratifying recoveries. The method has given not only a very high percentage of recoveries but for the most part has done so without septic complications (secondary foci), damaged adjacent joints, deformity, or other complications. Operation should be done early, if possible, and drainage, at whatever time the patient is seen, is a consideration of primary importance. The following was an early case:

CASE 7.—A boy, aged nine, was brought to the hospital with an osteomyelitis of the tibia of seven weeks' duration. He had had a daily rise of temperature during the entire time up to 102° to 104° F. Roentgen-ray examination showed extensive damage to the lower third of the tibia. Operation was done as described. Several ounces of pus and a considerable amount of diseased bone were removed from the lower third of the leg. Dressings and a cast were put on as usual. This patient was operated upon about April 28, 1923, and no dressing was done for forty-six days. The patient's temperature dropped to normal on the second day following operation and did not rise again. The wound was soundly healed in sixteen weeks.

As suggested previously, my method was designed primarily with the chronic osteomyelitis patient in mind. The factors that were considered to be of importance in the development of the method were that the patient had to some extent become accustomed to the infection he was carrying and might be relied upon to protect himself if the amount of this infection were cut down and if he were protected against further infection.

I was repeatedly warned, by those with whom I discussed the method, not to employ it in acute cases. After several experiences, however, in which quite severe acute infections, especially in connection with compound fractures, were dealt with in this manner, I became quite certain that the method was applicable in the acute osteomyelitis case.

The course of reasoning was the same: if in an acute case the amount of infection could be cut down by a suitable drainage operation, if the patient could be protected against further infection, and if he could be immobilized and otherwise assisted towards recovery by correct splinting and so on, he might be relied upon to take care of whatever small amount of infection it was found impossible to remove at the primary operation. Moreover, the importance of doing away with the daily irritation of the wound and wound surface by irrigations, dressings, and the like, was in line with the plan which had already been demonstrated to be so successful for other infectious wound complications. Consequently, I began to employ the method in acute cases, and here some of the most brilliant and satisfactory results were at once obtained. In a considerable series of cases, in fact, there has been only one death following the application of this method in acute cases. This was a girl, sixteen years old, who died of endocarditis and acute nephritis about a week after operation, even when the local condition where the operation had been performed seemed to be clearing up. All of the other patients with acute osteomyelitis have been relieved immediately by the drainage operation of pain, temperature, septicemia, and so on, and have recovered without complications. The period of confinement in plaster cast has usually been from about eight to sixteen weeks, and the operative wound has been healed at the second or third dressing.

One of the striking illustrations of this method in acute cases occurred in a patient of Dr. Akin, of Portland, Oregon. I was called upon to operate upon this child about nine o'clock in the evening. The child, five years old, had been in the hospital two or three days with the typical symptoms of an acute osteomyelitis of the hip—a temperature of 102° F., pain, moderate swelling, limitation of motion, and so on, with a white cell count of about twenty thousand.

There was some question in the minds of the attending physicians as to whether or not pus would be found. With Dr. Akin's permission, however, an incision was made just in front of the great trochanter down to and through the periosteum. There was no pus under the periosteum.

Figs. 7, 8, 9, and 10, a series of four x-rays, are submitted to illustrate several points in the conduct of a case of acute osteomyelitis.

Fig. 7.—The beginning changes in the metaphysis which were apparent in this case after only four days of acute symptoms. The indication in such a situation is for drainage of the metaphysis. In this case no pus was found after incision had been made through the periosteum, but pus in considerable quantity was found in the interior of the bone after an opening had been made through the cortex.

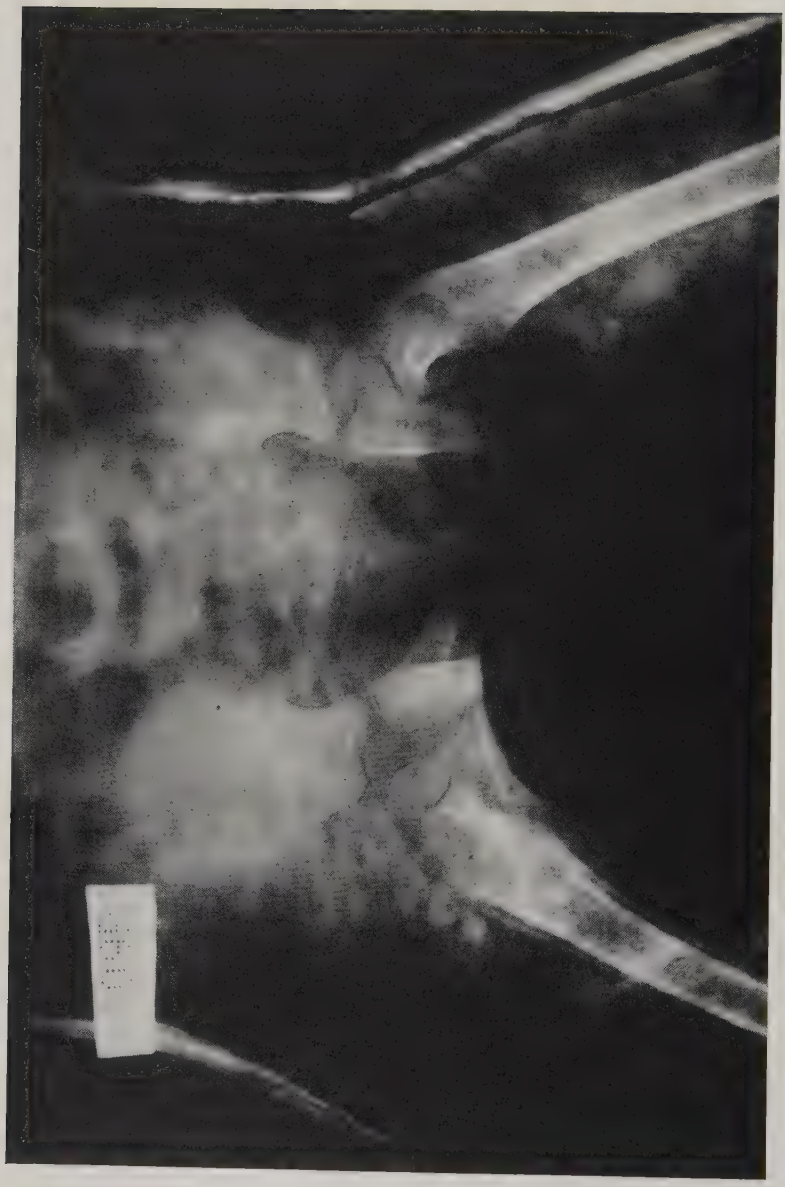

Fig. 8.—This shows the appearance of the patient in the cast, following the operation. A good-sized window was made in the bone and both extremities were thoroughly immobilized in the double spica cast.

Fig. 9.—The healing process has become established. There is some bone production about the infected area. It is to be observed, however, that on account of the fact that there was adequate drainage the process did not proceed to the formation of a sequestrum nor was there loss of the head of the femur as commonly occurs in these cases.

Fig. 10.—This radiogram taken three months after the operation shows repair progressing rapidly. The wound was soundly healed at this time and has remained healed now for about one year. Return of normal appearance and function of the limb has been complete.

Again the question was raised as to whether, under the circumstances, the bone should be explored. It has been my practice to do so invariably, and pus is practically always found in the interior of the bone. It was so in this case. A window was made in the bone just in front of and above the great trochanter. As soon as the cortex of the bone had been opened, a considerable quantity of thick yellow pus escaped. The opening in the cortex was enlarged to about one-half inch by three inches, extending up to about the epiphyseal line, and the entire wound including the bone and soft parts was packed widely open with vaseline gauze; no wicks or sutures were employed. The wound area was covered with vaseline gauze pack and then a dry dressing. A double spica cast was put on. This patient entirely recovered and with no disability; the report showed, on the contrary, that in about two months she had a full range of motion in the hip and in all the joints on the affected side and walked without a limp, pain, or any other indication of disability. The legs measured the same length, and x-ray pictures indicated a full restoration of the femur, the wound having healed from within outward, converting the operative wound into a small, good looking scar—all drainage having long since ceased.

One very interesting feature of this case is that with the rapid and complete recovery of the acute infectious bone lesion there was—in the double spica cast—an extension of the soft part abscess to the inner side of the hip and thigh. Evacuation of this abscess through an incision at the vaginal opening on about the tenth day resulted in prompt healing without further complications.

There has been a considerable amount of discussion recently regarding acute epiphysitis of the head of the femur. There are undoubtedly good grounds for the belief that acute suppurative epiphysitis at the end of any bone may and does occur. It is my opinion, however, that this diagnosis which is usually made at the conclusion of a case, a diagnosis based upon the appearance of the epiphysis after

the damage has been done, is incorrect for some of these cases. Certainly an acute osteomyelitis originating in the metaphysis and involving the neighboring joint will give at the end of the attack, if the patient survives, the appearance of an acute suppurating epiphysitis (See Figs. 7 to 10 of the preceding case; also Figs. 11 and 12). Conversely, an acute osteomyelitis near the upper end of the femur adequately drained before the epiphysis or the joint have been damaged, as in the preceding case, will give a cured patient in which the x-ray signs of acute epiphysitis do not appear. In any case of acute suppurative trouble near the hip joint, the upper end of the femur should be explored surgically and, if intramedullary infection is found, adequate drainage provided. Secondary infection should be carefully avoided and adequate immobilization provided during the entire inflammatory period. Attention should also be directed to the importance of dealing promptly not only with the primary lesions in these cases but with secondary foci, if they appear.

There is a stage between the acute attack and chronic osteomyelitis, as usually understood, during which it has been the custom of surgeons to wait for sequestrum formation and the building up of an involucrum that will protect the integrity of the bone. I have determined to my own satisfaction that a waiting policy during any period of this sort is a mistake. Osteomyelitis should be drained when seen by the surgeon. If the patient is carrying a septicemia, endocarditis, nephritis, or any other condition obviously the result of a primary infectious focus, it should be drained immediately by the simplest and most thorough method that can be applied, after taking into consideration all of the factors in the patient's condition. In almost every discussion of this subject in which I have taken part, one important point comes up; there is always some one to claim that the matter of surgical operation (or even of surgical dressing after operation) must in the last analysis be left to the "judgment" of the attending

surgeon. This sounds well, but it is frequently the wrong attitude nevertheless. If the attending surgeon is timid, has had a limited experience, lacks technical knowledge, or has not the equipment for carrying out the necessary surgical procedure or for applying suitable traction or cast, he should not rely upon his judgment, but obtain consultation or assistance without delay.

Adequate drainage, however, is the one thing necessary in any stage. Added to this, of course, should be protection against further infection and immobilization of the inflamed parts in correct position.

A method which I frequently employ has been to place the patient, if contracture deformities have already developed, in a plaster of Paris cast with moderate correction of the deformities and then do whatever drainage is necessary through a window in the cast. This protects the patient not only against progress of the deformity but against manipulation of the inflamed parts during and following the drainage operation. This is a point of considerable importance. The following is another illustration of the method of dealing with a patient in the late acute stages:

Case 8.—A. T., aged four years. This little girl was brought to the hospital on August 29, 1926, with an acute osteomyelitis affecting the right hip and left foot. The lesion in the left foot was the primary one and had existed for about seven weeks; the right hip became involved two or three weeks after that. About two weeks before coming to the hospital the left foot and ankle were incised and some drainage of pus was obtained. At the time of admission the right hip was badly swollen and evidently contained fluid. No x-ray pictures had been taken. Upon making an x-ray examination the head and neck of the femur were found to be almost entirely destroyed, with bone fragments lying loose in the abscess cavity. There was marked contracture deformity of both lower extremities which could not be straightened out, as the child would scream when any effort was made to move her. She had a daily temperature up to 102° or 103° F. Although her condition was not very favorable, she was operated upon the same evening. An opening was made into the tarsus of the left foot and a long incision over the great trochanter down to the bone was made into the right hip. The hip abscess cavity was evacuated without difficulty and a large amount of pus and débris was wiped out with gauze. Both wounds were packed wide open with vaseline

Fig. 11.—The condition of this patient, A. T., as to external appearance two years after operation is shown. There has been no recurrence of the infection.

gauze. Under the anesthetic the limbs could be straightened without much difficulty, and she was put in a double spica plaster cast with all the parts, including the left foot, in correct position. The cast extended from the axilla to the toes on both sides. The patient was put to bed with the foot of the bed elevated and traction put upon the leg with a weight over the foot of the bed, her head and shoulders thus acting as countertraction to relieve the muscle spasm otherwise incident to lesions of this sort.

Fig. 12.—The head and neck of the femur are almost entirely destroyed, but the patient walks very well and has no pain.

Following the operation she was given Fisher's solution by rectum and carefully built up with hot liquids, and so on for the first twenty-four hours. Her general condition began to improve at once. No dressing was done on either foot or hip for one month. At the end of the second month the hip wound was entirely healed. She had no rise of temperature after the second day following the operation and no other areas of involvement. She made a complete recovery from the septicemia from which she was suffering when

admitted to the hospital, being apparently well in a few weeks. A plaster spica was kept on the hip until the following July and the right ankle was healed May 1, 1927. There has been no recurrence of the active infection in either hip or ankle. The condition of the hip and the patient at the present time are shown in the illustrations (Figs. 11 and 12).

I have treated about thirty cases of acute osteomyelitis, by my method. Only the one death, previously referred to, and two or three instances in which there were secondary complications have occurred to mar a perfect result with all of these cases. This seems to be a better showing than most; I know of no better. I therefore feel that no few lives may be saved and no little amount of suffering and disability prevented if the method described here is used and strictly adhered to. One other rather striking acute case is added as illustrating certain other features of treatment:

CASE 9.—R. S.,[12] aged six years. This child came two hundred and fifty miles on the train and was admitted to the hospital September 1, 1926, with a temperature of 105° F., pulse 140, respiration 32, white blood count 28,000. There had been pain in the knee and thigh for three days previously. Hot packs had been used to allay the discomfort, but during the last twenty-four hours the least movement of the left lower extremity caused severe pain. The temperature when last taken, twelve hours before admission to the hospital, was 106° and had been 104° F. the day before.

The lower third of the left thigh was swollen and tender. There was a definite redness radiating to the outer side of the front lower portion of the thigh. Movement of the knee or hip caused severe pain. The child was negative as to other physical findings except for mild furunculosis on the back of the neck and infection of one finger. X-ray findings were negative as to any bone lesion.

The child was taken to the operating room with a diagnosis of acute osteomyelitis of the lower third of the femur. (Operation by Dr. J. E. M. Thomson, the author assisting). An incision about six inches long was made laterally just behind the quadriceps group. The skin, muscles, and periosteum were reflected, and a small chisel hole was made in the cortex of the metaphysis just proximal to the epiphyseal line. Immediately a yellow, creamy pus welled out. The opening in the bone was extended to about three inches long and one-half inch wide so that the entire lower third of the femur was well drained.

Pus exuded freely and was apparently under pressure. Very little curetting of the medullary cavity was done, and the wound was filled to the

[12]Previously reported in Surg., Gynec. Obst. **14**: 462, Oct., 1927.

depth of the medulla with a vaseline pack and a double plaster of Paris spica cast was applied. In twelve hours his temperature had dropped to 99°; it went up in the afternoon to 101°, but was down the next morning. The temperature ranged within these limits for three days; after that the temperature remained under 99.6° for four days, after which he had a normal temperature, once or twice rising to 99° and a fraction.

At the end of six weeks the cast was removed and the dressings taken out. There had been considerable drainage under the cast, but upon removal of the vaseline pack it was observed that the wound had filled in to practically one-half the depth and was covered from the base with healthy granulation. A new single spica cast was put on and worn for a month longer, then it was removed and the wound was found to be healed, with the dressings pushed entirely out of the wound and the serum which had come from the wound entirely dried.

This wound which originally had gaped open about two inches, is now closed to less than one-half inch at the widest portion of the scar. The boy was placed in a double lateral iron brace and physiotherapy, massage, and active and passive motion instituted. He was soon up and around, showed no temperature, and was by January 10, 1927, apparently entirely well. The picture (Fig. 13) shows him at this time.

A kind of acute osteomyelitis in which extremely gratifying results have been obtained is one in which the results are usually local rather than general but in which in the past we have all had serious and even fatal results. Such a case is the patient with an acute osteomyelitis of the phalanx of the finger, commonly referred to as a felon. The usual treatment of a felon has been either poultices and then drainage, or drainage and then poultices, with the result that maceration and sloughing have usually occurred.

Such cases call for a thorough incision down through the periosteum. If the bone is found to be soft, a further opening into the bone is made. A vaseline dressing is placed on the finger, and the hand and arm are carefully splinted so that there is no motion or disturbance for a week or ten days. No changes of dressings are made for one or two weeks. There is no sloughing even when the distal phalanx of the finger is the one involved, and the finger is usually found to be healed with no stiffness or loss of motion in about ten days or two weeks. The following is

Fig. 13-*A*.

Figs. 13-*A* and *B*.—This patient, R. S., was seen so late in the acute attack that changes in the bone had already occurred. X-ray shows condition at the end of treatment. See Fig. 14.

Fig. 13-*B*.

a report of a typical case. There have been a considerable number of surgeons who have followed this method with the same results.

Case 10.—Mrs. F. T. was seen after about a week of severe inflammation of the first finger of the right hand on account of a felon. The finger was

Fig. 14.—Condition of patient, R. S., in January, 1927. Soundly healed and has remained so.

Figs. 14-18 reprinted from *Surg., Gynec. and Obst.*, 45: 446-464, Oct., 1927.

greatly swollen, the swelling extending back into the hand. For two nights previous to coming for treatment she had been awake all night with pain except for short periods of relief under opiates.

The treatment of incision and rest applies with special force to these finger infections. In this case free incision was made along each side of the second phalanx down to and through the periosteum. A few drops of pus were evacuated from the radial side of the finger only. A narrow wick of vaseline gauze was put in; the finger was wrapped in vaseline pack, and the entire hand placed on a long cock-up splint. After padding the finger carefully, the hand and fingers were bandaged to the splint. Neither the splint nor the dressings were disturbed for one week. The pain was relieved within a few hours. The patient was so anxious to see the dressing that it was changed at the end of one week. All the swelling of the finger and the hand had subsided and the wound looked very well, except that there were a few drops of drainage. The wound was swabbed with iodine, a vaseline pad was placed around the finger again, and the splint put on. This was left on for the second week and then removed. The finger was found to be entirely healed. Within another week all motion had returned to the finger, it was free from pain and stiffness, and has remained well since that time—about two years.

Numerous felons have been treated in this way with as good results, but it is not necessary to add further case reports. The old method of incisions, poultices, antiseptic dressings, and the rest resulted in destruction and deformity; the method of drainage and rest offers better results.

It seems obvious, then, that the Orr method may be used with superior results in the treatment both of acute and chronic osteomyelitis. The advantages of this method are worthy of summary, but first will be listed the steps in the method.

1. Make a fairly large incision over the infected area. Spread apart the skin, muscles, fasciae, and periosteum just far enough to afford access to the diseased area, and no farther.

2. Chisel a window into the affected bone area large enough so that all diseased and necrotic (but not infected) bone may be removed, so that all pus-pockets within are reached, and so that no overhanging edges of bone remain in the diseased area—the bone is "saucerized" as described by Ryerson.

3. Clean out the diseased area gently with a curette or gouge, being careful to damage tissues undergoing repair as little as possible.

4. Dry the cavity and wipe out with 10 per cent tincture of iodine, followed by 95 per cent alcohol. (Fig. 15.)

5. Pack entire wound wide open, but not tightly, with a sterile vaseline gauze pack. Cover this with a dry sterile pad, and bandage on. (Figs. 16, 17, and 18.)

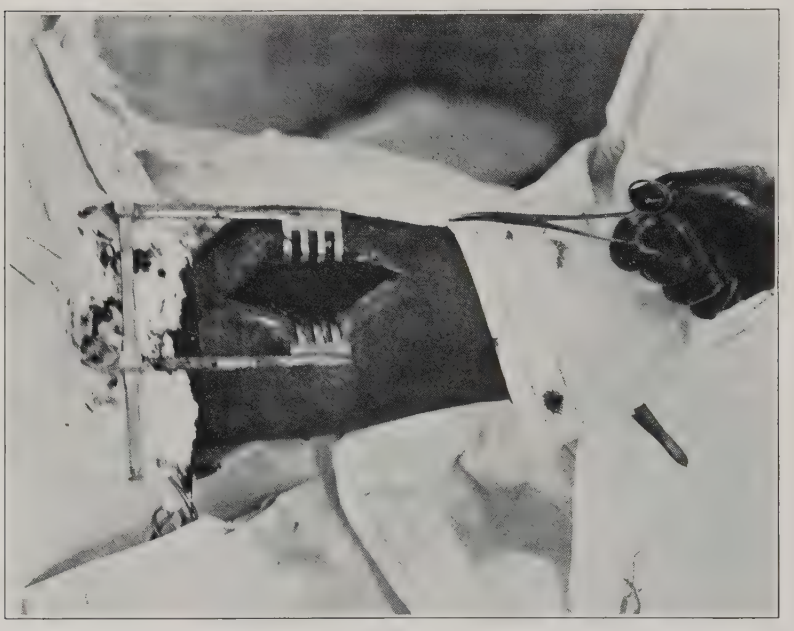

Fig. 15.—Cavity remaining after removal of sequestra. "Saucerization" or "effacement" of diseased area.

6. Now perform any reasonable forcible manipulation necessary to place the parts in their correct anatomic position for splinting. (Abduct the arm to 90° in humerus cases; dorsiflex and supinate the hand in forearm and wrist cases; dorsiflex the foot to a right angle with the leg in leg and foot cases; and so on.)

7. Apply a plaster of Paris cast if possible, otherwise a suitable splint so that the parts are thoroughly immo-

bilized in comfortable and correct position. (Additional weight and pulley traction, a Balkan frame, or even ice tongs or bone pins may be used, especially in those infected bone lesions associated with fractures and old fracture de-

Fig. 16.—Entire cavity—bone and soft parts—being packed widely open with vaseline gauze. No drainage tubes are employed.

formities which are being corrected at the same time as the clean-up operation. Good results have been gained by this method.)

8. The cast is not to be split nor are windows to be cut until the wound dressings are necessary. And wound dressing is not necessary for some weeks. The wound is

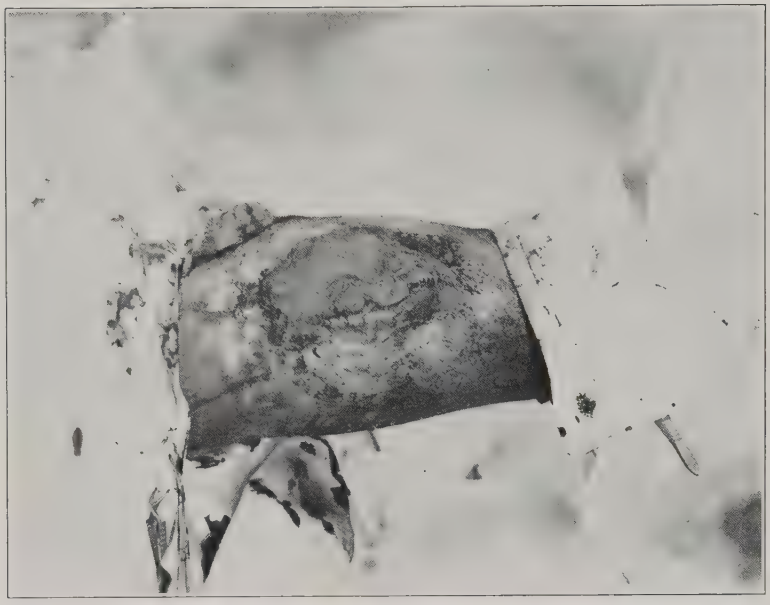

Fig. 17.—Cavity and entire wound packed open with vaseline gauze. No stitches or drainage tubes are employed.

Fig. 18.—Final covering with vaseline gauze. This is again covered with an absorbent cotton dressing firmly bandaged on and then a plaster of Paris cast is applied.

not to be dressed at all except for rise of temperature or other signs of acute sepsis. As a rule, no dressing is necessary except on account of odor; and then not for two weeks or more. (Figs. 42 and 44.)

One or two further observations may be helpful: (1) patients will usually heal without complications, having dressings as infrequently as from ten days to four weeks if all aseptic precautions are taken; (2) patients do require watching for possible complications, but these should not occur, and (3) the plaster cast has been objected to on the ground that it cannot be kept clean for wet dressings, and that when soiled by drainage it becomes unsanitary, but wet dressings are not used in this method, and the drainage has rarely been sufficient to saturate the dressings next to the wound, not to mention damaging the cast. These possible minor disadvantages are not to be considered seriously so long as the advantages of rest and immobilization are obtained.

The Orr method deserves attention for a number of other advantages. There is, in the first place, the single operation, if the entire infected area can be drained at the time of operation. The old practice of primary partial drainage and secondary continued drainage with removal of sequestra, and so on, made for an elaborate series of operations. No little amount of time and expense is saved when only one operation is required as is the case in most of the operations done by this method.

A great advantage is found in the comfort afforded the patient. If one recalls cases of children with osteomyelitis and remembers the screams which heralded the preparations for the daily dressings formerly used, the contrast is marked. Sedatives are rarely needed after a properly applied Orr dressing, for proper rest and immobilization following thorough drainage eliminates the factor of pain from osteomyelitis cases.

The ease with which the surgeon can treat these cases is also to be considered. When dressings come no more

frequently than from ten days to several weeks, the surgeon can attend to them himself. The attention of nurses and assistants is eliminated. The psychologic advantages of rest, freedom from worry, and the like are to be taken into consideration; while the more remote advantages of rest in the correct anatomic position to prevent muscle spasm and the virtual elimination of deformity, contracture, and ankylosis are significant. Added to these are the usual aids to the patient in a shortened period of hospital treatment, a shortened period of convalescence, and other savings in money; and to the surgeon a higher percentage of cures with a lower percentage of complications and undesirable after effects.

Lest these promises sound too much exaggerated, a number of cases treated by the Orr method by other surgeons are to be held back for a final chapter. This array of evidence should determine the usefulness of the Orr technic in the hands of surgeons generally. Meanwhile, let us turn to a discussion of the method in its application to compound fractures.

CHAPTER IV

Compound Fractures

The treatment of osteomyelitis as it occurs in compound fractures is to be discussed apart from the treatment of acute and chronic osteomyelitis for the reason that the fracture has to be treated at the same time, and this gives rise to conditions which are best illustrated by a different set of cases. The term "open fractures" has been preferred by some writers on the subject. Whatever the name, however, the reference is to all those fractures which are infected following the penetration of bone fragments through the skin, whether the infection is hematogenous or from the introduction of foreign and infectious matter from outside.

It is possible to criticize the present usual treatment of compound fractures as severely, if not more so, as it has been necessary to criticize the treatment of osteomyelitis. Surgical procedure during the war, when numerous gunshot wounds resulted in severely infected compound fractures, was characterized, as we saw, by such methods that large numbers of preventable deformities resulted. Other methods, as has been pointed out, have tended to sacrifice the principles of orthopedic treatment to the supposedly necessary, but actually dangerous, combating of infection in the wound. In dealing with compound fractures it is quite essential that the affected bones have primary attention if the best results are to follow.

When a compound fracture occurs, the bone or bones involved are not only broken, but are also thrown forcibly out of their normal position. It is therefore of paramount importance that these bones be restored as nearly as possible to their correct position, and that between the time of fracture and the time of restoration as little damage

as possible be done to the tissue surrounding the fracture. To insure this, it is the best practice to splint the patient at the scene of accident, if possible, thus insuring a minimum of damage to the tissue; then when operation is possible, the bones are put into correct position and immobilized. And it is highly important that this immobilization be maintained. Wound treatment is secondary in that it is possible to provide an aseptic wound which will heal easily and satisfactorily while at the same time giving primary consideration to the fractured bone. When this process is reversed, and too little attention given the fracture, the

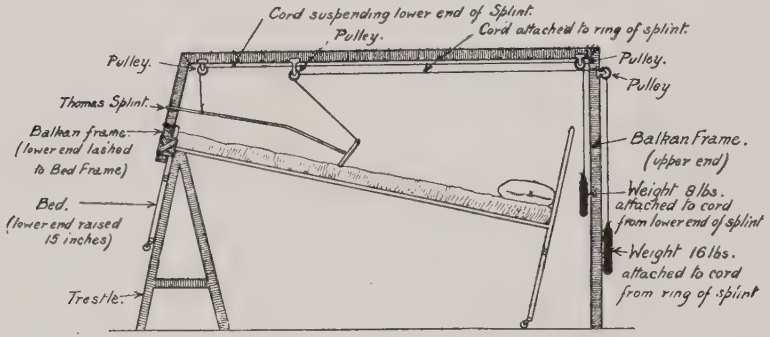

Fig. 19.—This diagram shows a proper arrangement of the mechanical factors involved in the treatment of a patient with fracture of the femur in a Thomas splint—except one. It is supposed that true intrinsic traction is applied to the limb within the splint. That is, there should be a pull on the limb against the lower end of the splint and with the ring of the splint against the tuberosity of the ischium. This is very rarely correctly done. Commonly the limb is laid in the splint and lightly fastened by traction straps to the lower end of the splint. The ring is usually too large and makes pressure nowhere. Finally, a weight and pulley are hung on the lower end of the splint to pull on the leg and neither traction nor immobilization is good enough. This gives us simply a sort of Buck's extension in a Thomas splint which is poorer than either one. (From *J. Ortho. Surg.* 2: 196, April, 1920.)

amount of deformity and disability is increased; and such is the present state of affairs.

The attitude of most surgeons toward the treatment of compound fractures during the war and since is summed up in a recent book by Dr. L. W. Ely. Discussing suppurative osteomyelitis following compound fractures, he says:

"The treatment in the first place is prophylactic. Com-

pound fracture which is considered clean may be treated expectantly but at the first sign of infection it should be thoroughly opened up. All foreign material and necrotic or loose bone fragments should be cleaned out, but bone fragments still attached to the periosteum should be left. Their presence is said to promote the union of the fracture. Provision should be made for drainage and if possible some

Fig. 20.—To illustrate a simple method of obtaining abduction and traction by means of a rough board slipped between mattress and bedspring and holding by friction. (From *The Treatment of Fractures by Suspension and Traction, Surg. Gynec. and Obst.*, March, 1918, by Dr. Jos. A. Blake and Dr. K. Bulkley.) It is my opinion that while many excellent results have been obtained by the above method, the immobilization provided by this apparatus is inadequate for a compound fracture, especially if infection and inflammation are present.

form of wound disinfection should be installed—Carrel-Dakin. If in spite of our efforts, the infection spreads, amputation may be necessary.

"Nonunion frequently follows infected compound fractures. It is not well to undertake *any* operation for this until after the wound has been healed for several months. Otherwise we run the risk of lighting up the infection afresh."[1]

A discussion such as this does scant justice to the subject. By prophylactic treatment it is intended, of course, that the wound shall be cleaned up. During and since the war, this has usually meant a débridement. Unfortunately we have had no rules about débridement except to leave bone fragments attached to the periosteum and to take out all foreign material and devitalized tissue. And while the method has contributed somewhat to a better surgical technic in the matter of gloves, instruments, and so on, it has nevertheless meant either too much or too little in the way of extracting material. In many cases, the wounds have not been properly cleaned because the surgeon hesitates to open up and take out tissue; in other cases, too much has been taken out, tissues and parts that might have been used to advantage later on.

In one respect, however, the prophylactic treatment has often failed because of closure and partial closure of such wounds with inadequate drainage. In a large number of cases, suture, drainage tubes, and secondary dressings have led to wound infections with a long delay in healing. This is due again to the precedence unnecessarily given the wound over the fracture during treatment.

In treating such a case "expectantly," the surgeon sits by in the hope that infection will not develop; and when it does, he resorts to all the pseudoListerian devices he can lay his hands on: drainage tubes, the application of antiseptics to the wound surface, daily dressings, irrigation, packs, and the rest. The fact that a fracture is involved is forgotten, and the results are generally poor.

The shortcomings of the method of primary closure have been listed previously. It may be said in passing, how-

[1]Ely, L. W.: Inflammation in Bones and Joints, Philadelphia, 1923, J. B. Lippincott & Co., p. 99.

ever, that in compound fractures generally, no less than in gunshot wounds, it is virtually impossible to be sure that a wound is clean. And to close it up after no matter how thorough a mechanical cleaning and an antiseptic sterilization is usually to close up no little potential infection. The fact, as has been suggested, that surgeons are able to point to a number of successes where primary closure has been used demonstrates, not that the wound has been thoroughly cleansed, but that the body, by its own processes, is naturally able to cope with a good deal of infection.

It may be said, in a word, that the principal defect of fracture treatment is the principal defect of osteomyelitis treatment: failure to heed the orthopedic principles involved. Summarily put, the usual mistakes are: (1) that primary attention to the wound takes precedence over immediate reposition of the fractured fragments which ought to be put at once into their correct anatomic position; (2) splinting in the correct position is also disregarded in the interest of wound treatment; if splints or casts are used at all, their use is made subservient to the care of the wound to the utter disregard of orthopedic practice; (3) the primary operation in many cases consists in closure, which is likely to be unsuccessful, or partial closure with the insertion of a drainage tube, whereas wide open drainage without the use of tubes and usually without suture should be the rule; and (4) that the use of secondary antiseptics, such as daily dressings or irrigation,—now considered unnecessary,—tends to delay healing and frequently leads to secondary, mixed infection.

Unfortunately, most surgeons are satisfied with their methods and results in the treatment of compound fractures. Only a few realize just how bad our results are. A large number of patients having such injuries are turned over by the surgeon, after the operation, to his assistants or associates; these—comparatively voiceless in surgical literature—are the ones who know how many deformities

and disabilities there are because of nonunion, malunion, and chronic infection. Such patients often leave the original hospital or surgeon before recovery; and frequently, still 100 per cent disabled, they drift from place to place neither checked up nor remembered by the original hospital or surgeon.

It may seem at first glance that this is a greatly exaggerated statement of the situation. Figures compiled by the office of the Surgeon General, however, show that such is not the case. Though the war may constitute an exceptional experience, it must at least be conceded that these

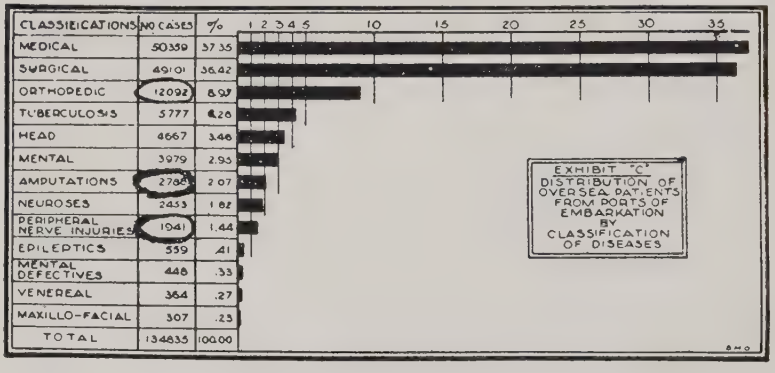

Fig. 21.—Taken from the report of the Surgeon General, United States Army, 1919. Of the cases particularly indicated above I estimate that about 75 per cent passed through Base Section No. 1, A. E. F., from August, 1918, to March, 1919, while I was Consultant in Orthopedic Surgery in that area. Col. Joel E. Goldthwaite was Chief Consultant in Orthopedic Surgery for the A. E. F. The hospitals in Base Section No. 1 which were most active in the care of this class of cases were Base Hospitals 8, 69, and 88, at Savenay, Base Hospital No. 101 at St. Nazaire, Base Hospital No. 34 at Nantes, and Base Hospital No. 27 at Angers. Major Philip D. Wilson was the Consultant in charge of amputation cases. Major LeRoy Abbott was Orthopedic Surgeon in Base Hospital No. 8, and Major Murray C. Danforth in Base Hospital No. 69. The problems that were uppermost in the minds of all of us during that period were those of dealing with compound fractures, infected wounds, and similar injuries, so that the patients might be prepared for safe transportation to the United States.

figures suggest conditions now; and to me, at least, comes the irresistible suggestion that the truth is, not that the war created an exceptional condition of affairs, but that the methods by which we treat fractures are wrong.

There were some sixteen thousand fractures among American troops during the Great War. Quite accurate information exists concerning the nature of injury, the kind of treatment, and the results. Statistics used here will be those covering fractures of the femur. And here is our record:

Of the cases studied, eighteen months after injury
1,725 patients had less than 50 per cent disability.
1,616 patients had more than 50 per cent disability, of whom some 955 had 100 per cent disability.
Three years after injury
1,806 patients had less than 50 per cent disability.
1,546 patients had more than 50 per cent disability, of whom 282 still had 100 per cent disability.
Eight years after injury
1,841 had less than 50 per cent disability.
1,546 had more than 50 per cent disability.

In another series of fractures of the femur from all causes, the disability in those observed for no definite period, but at the time of first and last examination (up to 1926) 2,669 of 5,138 patients were less than 50 per cent disabled while 2,469 were more than 50 per cent disabled, and of these latter 789 were more than 80 per cent disabled.[2]

To epitomize, about one-half of all the above patients were more than 50 per cent disabled at the end of three years' treatment. About 20 per cent were 100 per cent disabled after three years. And even after eight years more than a half of all the patients were more than 50 per cent disabled. Those are not good results; at any rate, they are not good enough. And our results today, even in good hospitals, are little, if any, better. We do not know the percentage of our failures, in most instances, because we do not keep track of them after the initial treatment.

The real point is, however, that we may obtain better

[2]See The Medical Department of the United States Army in the World War. ("Surgeon General's Report.") Volume XI, "Surgery" part 1. Washington, 1927, p. 546 and Table 76.

results if we will. The Orr method applies to the treatment of compound fractures just as to osteomyelitis. The important difference is this: that the fracture has to be treated as a part of the operation. Before any operation on the wound area is begun, the injured parts should be placed in their correct position and at the correct length. This often implies a certain amount of manipulation, but this is always kept at a minimum both as to the range and number of movements necessary. In old fractures which

Base Hospital No. 8, B. S. No. 1, American E. F.

	NO. ADMISSIONS DURING MONTH	AVERAGE DAILY NUMBER PATIENTS	NO. OF SCD CASES TO U.S.A. DURING MONTH	NO. DEATHS DURING MONTH
Sept. 1917	84	30	None	None
Oct. 1917	149	86	"	"
Nov. 1917	226	117	3	1
Dec. 1917	408	223	None	1
Jan. 1918	652	359	247	15
Jan. 1918	652	359	247	15
Feb. 1918	356	380	83	3
Mar. 1918	1115	683	233	3
Apr. 1918	805	866	345	3
May 1918	423	709	158	2
June 1918	1559	1051	344	6
July 1918	2333	1735	657	4
Aug. 1918	3439	2257	1561	15
Sept. 1918	4834	2949	1885	20
Oct. 1918	7347	3721	3149	63
Nov. 1918	7057	4941	4897	31
Dec. 1918	1936	3867	2859	31
Jan. 1919	2472	2397	2160	20

Fig. 22.—From August, 1918, the number of orthopedic cases in the above chart was from 40 to 50 per cent of the entire number. These included gunshot fractures, peripheral nerve injuries, and amputations, and were part of the cases which I observed and studied in arriving at my conclusions.

have already resulted in shortening or deformity, correction and length may be impossible to obtain until the fractured area or the area of osteomyelitis has been cleaned out. Even in such a case, however, the patient is placed upon a fracture table, or in a preliminary cast to be operated upon through a window, before the operation is begun, and a favorable position is secured so that, as the operation proceeds or when it is finished, the desired final

position of parts may be had with as little further manipulation as possible. Following the operation and the application of a plaster of Paris cast, if one has not been applied previously, there should be no motion, muscle spasm, or any other disturbance of the parts.

In some cases the primary injury or the primary infection may be so severe that no hope of repair or recovery may be reasonably entertained. The point that we do not always recognize, however, is that the possibilities of any such situation depend to a very large extent upon the measures that are brought forward to cope with it. Certainly the matter of judgment as to operation or other treatment may often determine whether or not an injured limb is to be amputated or saved; and, to go a step farther, it makes all the difference in saving the life of a patient whether an amputation is done under certain conditions or under certain others. It is important to remember that the saving of life and limb depends in many instances not upon the injury alone, but upon the treatment. The measures that minimize shock, dispense with secondary trauma, and conserve strength, tissue, and blood for the patient are those upon which we may depend in our efforts toward his recovery. Measures that make for disturbance, further infection, and disease, on the other hand, are not helpful; they rather hinder the patient in his own efforts to recover.

Success in fracture treatment depends upon our ability to obtain correct length, position, and immobilization of the bone fragments and the injured part. The principal factor that interferes with success is muscle spasm. If there is failure in the first instance to obtain length and correct position in the fracture area, there will be muscle spasm, pain, and ultimate failure to get a good result. Even with a successful primary reduction of the fracture, if there is inadequate immobilization, or poor splinting, there will also be muscle spasm, pain, and often, if not always, a poor result.

These principles, applicable to simple fractures, become doubly important when the fracture is compound. When the complicating wound and its treatment are permitted to interfere, either primarily or secondarily, with reduction or immobilization of fractures, deformity and unduly prolonged or permanent disability are the rule. It has been amply demonstrated by statistics in recent years that correct anatomic results and good function after fractures must go hand in hand. Deformity may lead to serious disability. There is always the temptation to blame bad results in fractures either upon the severity of the injury or upon the inability to control the patient. It is my belief, however, that correct position, adequate fixation, and simplification of wound treatment will overcome most of such difficulties in dealing with this class of patients.

Correct position with relief of muscle spasm and pain may be obtained at almost any stage of the treatment of a fracture. It is quite certain, however, that the best time to obtain length, position, and immobilization,—the best time, it may be said, both for the patient and the surgeon,—is immediately following the injury. It may be of use, therefore, to discuss briefly the use of traction devices. By fixed traction is meant traction that is applied when the fracture is reduced and so immobilized or fixed in the immobilizing apparatus that it and the fractured extremity remain undisturbed and unaltered until at least preliminary healing has taken place. The exact technic as employed by us is as follows: For compound fractures of the lower extremity, moleskin adhesive plaster traction straps are used, 3 inches wide and varying in length for fractures of the leg or thigh. The frayed ends of a strong, pliable rope are sewed into the distal end of the straps to be used for traction purposes. The straps are applied to both sides of the limb well up to the site of fracture, and bandaged into place with muslin bandages. The patient is anesthetized on a fracture table; traction is instituted by a muslin bandage about the foot, and the rope ends are

Fig. 23.—Application of traction to the foot as a preliminary to adjustment of a fracture or operation for osteomyelitis. As much pull as required may be made by the muslin bandage about the foot and the traction device at the foot of the table. This traction is fixed by the application of moleskin straps, the lower ends of which are turned back into the cast as it is applied or by the use of pins or ice tongs which are included in the cast. Thus "fixed traction" devices are "locked" into the cast before the foot bandage above is released.

Fig. 24.—Application of moleskin traction straps to the leg while it is held full length by the bandage about the foot. Following the operation upon the thigh (or adjustment of a fracture) the cast is applied and carried down to the point indicated by the index finger of the left hand, then the moleskin straps are turned back into and included in the cast. When the cast has set, the foot bandage can be cut and the leg does not "jump back" into the cast. We have true "fixed traction."

attached to the traction device by which a pull is made and continued until the limbs are of equal length. The cast is applied in the usual manner, as low on the extremity as the ankle. After the plaster has sufficiently set, traction having been continuously maintained by the foot bandage, the traction ropes are cut from the holding device, turned back against the leg portion of the cast, and embedded in the cast by several turns of plaster bandage, thus anchoring them and maintaining the traction. When the plaster is set, the muslin bandage anchoring the foot is

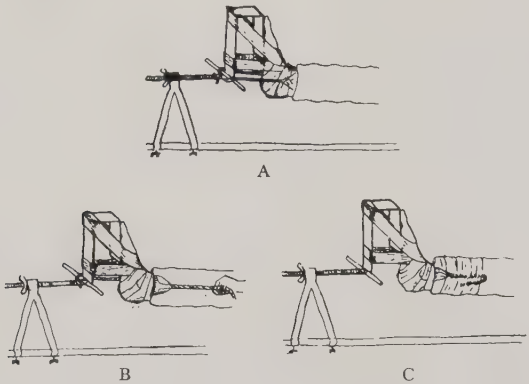

Fig. 25.—(Drawings by Dr. Thomson.) Technic of applying fixed traction by moleskin adhesive traction straps embedded in the plaster cast, as used for fractures of the lower extremity. *A*, traction established by muslin bandage and rope end of leg straps attached to pulling device of fracture table; *B*, rope end turned back ready to be embedded in cast; traction continuously maintained by muslin bandage; *C*, ropes embedded in cast; fixed traction established; muslin bandage may be removed, and cast applied to foot.

Figs. 25 and 26 reprinted from *The Journal of the American Medical Association* 83: 1399, 1924.

removed, and the foot is then wrapped in sheet wadding, and the cast applied with the foot at a right angle to the leg. (See diagram, Fig. 25.) In some instances it is necessary to use ice tongs or pins applied just above the condyles of the femur, at the ankle or through the heel. This may be done at any time when the fracture is near the joint, and when it is difficult to maintain traction and posi-

tion by other means. The pin is not used in the ankle, but in some cases may be put through the os calcis. In such a case, the pin or tongs are merely embedded in the cast, thus fixing the constant pull of the appliance, and securing the lower fragment in correct rotation. Eversion or inversion of the foot or lower fragment is difficult to secure or maintain. Such exact position can be secured and accurately maintained by manual control of the ice tongs or pin until it is "frozen" into the cast in just the position desired as to length and rotation. Ice tongs and pins are often the only devices that will give this kind of control in compound fractures. Attempts to secure such control

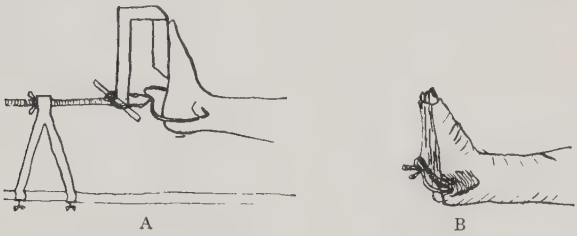

Fig. 26.—(Drawings by Dr. Thomson.) In a similar manner, ice tongs may be inserted into the condyles of the femur or into the malleoli while length and position are maintained by the pull of the bandage upon the foot. After the ice tongs have been included in the cast, the foot bandage may be released without loss of length of the limb. Control of the lower fragments as to rotation in thigh and leg fractures also is complete by this method. The cast having set with the ice tongs "frozen" in position and the traction bandage on the foot having been released, sheet wadding may be bandaged about the foot and the cast completed with the foot in correct position. On account of the fact that the traction is already fixed in the cast there is no tendency for the leg to pull back in the cast and consequently there is no pressure of the cast upon the dorsum of the foot or upon the heel. This remains true even if it is desirable to add additional weight traction to the leg over a pulley at the foot of the bed.

In this manner one has a true "fixed traction" with no muscle spasm and no danger of loss of position after the patient leaves the operating table. Moreover, complications on account of the skeletal traction devices (when employed) are entirely avoided, because there is none of the irritation or loss of position of pins or ice tongs so often seen when there is a tug of war between muscle spasm and weight and pulley traction.

by the insertion of bone grafts, plates, screws, wire, and the like, into an infected field can be mentioned only to be condemned.

Some surgeons have found difficulties in the use of this form of traction. It has been asserted that infection arises at the points where ice tongs and nails are inserted, that the

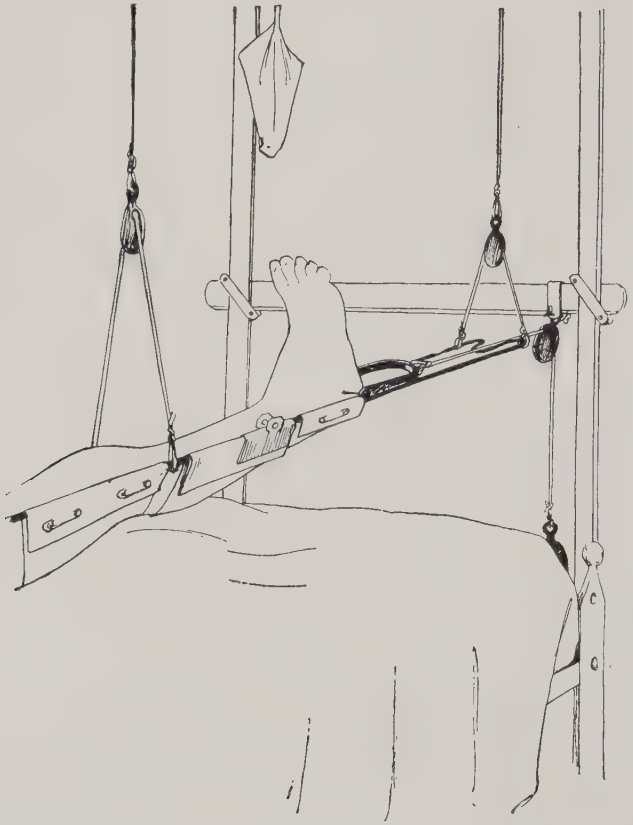

Fig. 27.—Skeletal traction on the os calcis. A Steinmann or similar steel pin is passed through the heel either over the top or through the center of the os calcis. To this pin, by means of an appropriate clamp, traction by means of weight and pulley is attached (used in connection with the Thomas traction leg splint).

Figs. 27 and 28 from *Outline of Treatment of Fractures.* Syllabus adopted at the Boston Conference, April, 1922. *Arch. Surg.* 6: 172-192, Jan., 1923, P+1.

points of ice tongs slip down from the bone into which they are inserted into the joints which lie below, and that, on account of necrosis, the pins or tongs tear through the bone.

It has been my observation, however, that these difficulties can usually be explained by the use of elastic (weight and pulley) traction and the corresponding lack of immobilization. In osteomyelitis and extensive infected soft part

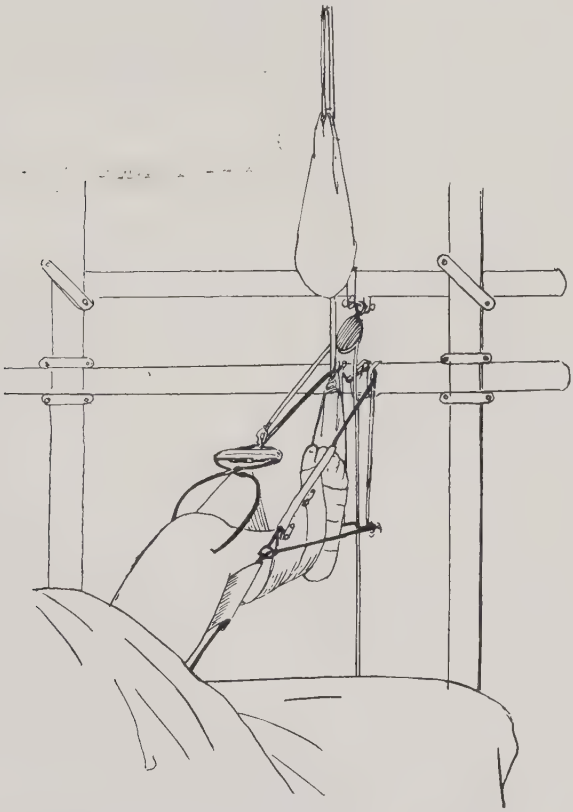

Fig. 28.—Skeletal traction in fractures of the femur. The points are introduced on a horizontal plane one-half inch (1.3 cm.) above and in front of the adductor tubercle. This shows the usual methods of applying skeletal traction in the Thomas and Hodgen splints. Muscle spasm is seldom fully overcome by this method, and a "tug of war" between the muscles and the weight is the result. Irritation and infection about the pin or ice tongs may occur, and loss of traction and position are common. Fixed traction in plaster avoids most or all of these difficulties and complications.

wounds we must have a kind and an amount of immobilization in correct position which is very rarely encountered in ordinary hospital and private practice. In a highly

specialized fracture service, like that in the Massachusetts General Hospital, for example, one sees skeletal traction in the Thomas splint properly employed. Too often, however, the splint as applied permits an amount of irritative motion of the injured parts so that there is an increasing battle between the elastic (weight and pulley) traction on the one hand and the spasmodically contracting muscles on the other.

Under such circumstances neither the fracture area nor the skeletal traction devices are ever under good control. Irritation of wounds and inflammatory complications are therefore to be expected and frequently occur. If, on the other hand, length and fixation are obtained and secured either in an adequate splint or in plaster at the time of operation or of first dressing of the patient, muscle spasm is entirely overcome at once, immobilization is complete, and complications affecting either the fracture fragments or the skeletal fixative devices should not and usually do not occur. And if, in addition to this, a primary clean-up of the injured area has been done and if a secondary infection of the wound is avoided by the simple expedient of "keeping out" afterwards, an uncomplicated convalescence is practically assured.

The Orr method and some of the characteristic problems encountered in treating compound fractures can perhaps best be shown in a series of cases. The first:

Case 11.—R. H. This patient sustained a compound comminuted fracture in an explosion of a compressed air tank on December 1, 1925. The fracture was in the lower half of the tibia and fibula, and there was a considerable amount of comminution and deformity. The accident occurred on the day when the Central States Orthopedic Clinical Society was meeting in Lincoln (December 1, 1925), and he was operated upon in the presence of some of the members.

Traction was applied on the Hawley table with a pin through the calcaneum. The leg was brought down to full length, and the wound cleaned up. No fragments of bone were removed as the small pieces were found firmly attached. The wound was allowed to remain open, however, and was gently packed with vaseline gauze. No dressing was done until December 30, 1925. A little later x-ray showed that there was some lateral displacement

of the fragments. A pin was introduced through the skin, the fragments were manipulated into nearly correct position, and the pin was driven into the lower fragment. The cast was renewed in such a way as to hold the pin and fragments in this position.

During the next two months dressings were done twice, the pin in the meantime having been removed. All wounds were soundly healed at that time and there was partial but not solid union. Complete bony union was somewhat delayed, and the leg was not considered to be solid until after about six or seven months. At about the seventh month the patient returned to work, not as a machinist but as a shoemaker, walking to and from work with the aid of a double lateral iron on his leg, and crutches. He continued to improve so that the swelling of the limb had almost entirely subsided at the end of the eleventh month and the limb was solidly healed in very good position.

There was at that time a small amount of shortening due partly to the bone defect and to the fact that exact approximation of the fragments had not been obtained. He had good ankle motion and weight bearing, for the foot and leg was and is about 95 per cent mechanically correct. There is slight pronation of the foot due to a spreading of the leg bones at the ankle joint which was entirely controlled for a time by means of an outside iron and an inside wedge on the heel. This has now been discontinued and the man walks with a slight limp.

Many physicians in general practice who treat thigh and leg fractures, and even many surgeons, have not taken into account the very distinct advantages of fixed, as against elastic, traction. In this country Buck's extension and the Hodgen splint have been used so much and, on the whole, so well that many excellent results have been obtained by these methods. Unfortunately the expedient of hanging any kind of weight over the foot of the bed with almost any form of anchorage to the foot or leg will also occasionally give a good result in these cases. A specialist, however, knows how many patients treated in such a manner end with malunion, chronic infections, inadequate surgical procedures (at home or elsewhere) failure to secure union, and even amputation. For all such cases better traction methods and immobilization are desirable. For those with inflammatory complications the use of fixed traction and plaster or well-fitting, efficient, comfortable splints is imperative.

The following case report is submitted to bring out a point that is becoming more and more impressive as the use of this method continues. It has been observed in many cases that with longer periods of immobilization for fractures and with longer periods between dressings, even in the presence of infection, we obtain repair of fractures and healing of extensive soft part wounds where we formerly resorted to bone grafts, fat flaps, fascia flaps, and the like. In this case an old nonunion of two years' dura-

Fig. 29.

Fig. 30.

Fig. 29.—Case 4. End-result of compound fracture in the lower third of the leg at the end of twelve months.

Fig. 30.—Case 4, R. H. Lateral view of patient shown in Fig. 29.

Figs. 29-33 reprinted from *Surg., Gynec.* and Obst., 45: 446-464, October, 1927.

tion and a discharging osteomyelitic abscess healed simultaneously by "drainage and rest" alone:

Case. 12.—W. C., aged 19, sustained a simple fracture of the lower third of the humerus in March, 1923. The first treatment failed to give union, and four times in 1924 and 1925 operations were performed. Three months before coming to the hospital in Lincoln, another operation was performed, and the fragments were strongly wired together. Infection unfortunately followed this last attempt, and when seen by us, there was not only non-

union and some deformity, but a stiff elbow and an osteomyelitis involving the entire lower half of the humerus. The patient was in poor general condition. (Fig. 31.)

Our operation (September 18, 1925) consisted of removal of all the wire and two sequestra through a generous incision. The entire wound was packed widely open with vaseline gauze and a body and arm cast put on with the arm well abducted, the elbow flexed, and the hand supinated. Following operation, the wound was dressed, and the patient was permitted to return to his home in Kansas. Four weeks later he returned for another dressing. The wound was almost healed, and about six weeks later was found quite

Fig. 31.—Case 5, W. C. Osteomyelitis. Nonunion two years after a simple fracture of the humerus. Five operations.

healed. While in the cast there seemed to be some improvement in stability at the point of fracture, and it was determined to stimulate bone production by chipping off a few fragments at the end of the fracture fragments. Through a window in the cast and subcutaneously (outside the scar area) a small chisel was inserted down to the fracture region and with a mallet a few pieces were chipped off and placed in the space between the ends of the bones. As expected, a certain amount of inflammation followed, and a small abscess formed which pointed near the olecranon. This was incised and drained and healed in a few days. To our great interest, we found at the end of the next six weeks that definite callus was forming and on April

16, 1926, the cast was removed and good union was found to have occurred. (Figs. 32 and 33.) A splint was kept on until December 18, 1926, but at the present time the young man is doing light work and using the arm to drive a car and for many other purposes. It is expected that later on, an arthroplasty of the elbow can be done to restore motion to the elbow. There has been no recurrence of the inflammatory process.

One of the most interesting cases of compound fracture with subsequent osteomyelitis in the care of which I have been associated was a patient of Dr. Dudley, of Seattle, Washington:

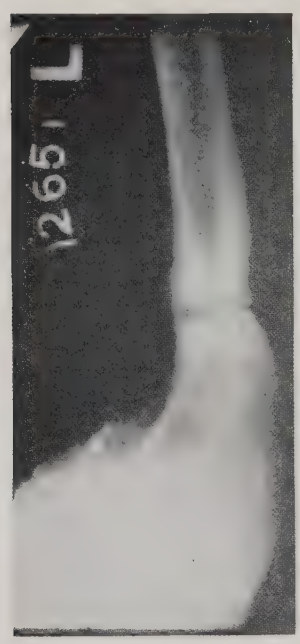

Fig. 32.

Fig. 33.

Figs. 32 and 33.—Radiogram taken six months after the one shown in Fig. 12. Two operations, 5 dressings, 3 casts, body and arm cast shoulder spica employed.

Case 13.—X. This patient was seen at the Swedish Hospital with Dr. Dudley on June 23, 1927. There had been a compound fracture of the middle third of the femur nearly a year before. Several previous operations had been performed, but the man was still in bed with a swollen limb, two discharging sinuses from the thigh, one in front and one at the back about the middle third, a malunited femur, bowing markedly outward, and an in-

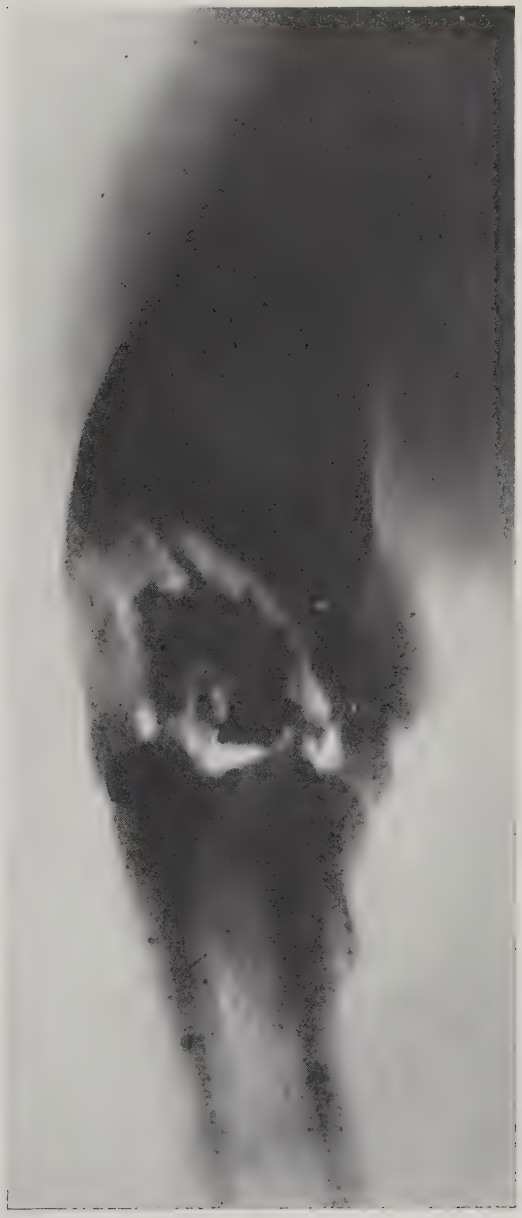

Fig. 34.—The condition of this patient just prior to operation. There was marked angulation of the femur upward with extreme shortening. The illustration gives an inadequate idea of the amount of sequestration formation, which was quite considerable.

Figs. 34 and 35 reprinted from *Surg., Gynec. and Obst.*, **47**: 235-238, Aug., 1928.

Fig. 35.—The condition of the femur immediately following operation. Correction of the deformity was obtained but without securing full length. Sufficient improvement, however, was obtained so that instead of about three and one-half inches shortening there was only a little more than an inch, as measured on the traction table. The gain in length was maintained by ice tongs inserted into the condyles of the femur.

complete union. The leg was about two and one-half inches short. An x-ray examination showed a cavity in the femur about two inches in diameter with a small amount of callus surrounding this cavity. (Fig. 34.)

On account of the large amount of scar tissue in front and back it was decided not to attempt to establish the new drainage through either of these areas. An incision about six inches long was made on the outer side of the thigh over the prominence caused by the outward bowing of the deformity. As a preliminary measure the patient had been placed on the operating table with traction applied to the foot in the manner I commonly employ, so that the line of the femur was corrected as the abscess cavity was exposed. The traction was gradually tightened up, and the limb brought down to a straighter position.

The small amount of callus around the abscess cavity broke, and the cavity was then thoroughly cleaned out. Several good-sized sequestra and a large amount of débris were removed. Some portions of the outer side of the femur were chiseled off in order to saucerize the cavity. The deformity was now further corrected by increasing the amount of traction on the foot, and the limb was straightened out quite readily.

Considerable bone substance had already been lost, but the limb straightened out well and the fragments were approximated. The entire cavity was now packed widely open with vaseline gauze, and ice tongs were inserted into the lower end of the femur. The bone was so thoroughly decalcified that in placing the points of the ice tongs into the condyles the shoulders of the tongs broke through the cortex, so that the entire ends of the ice tongs were inserted into the bone. There was some apprehension lest this amount of damage should give us bone infection at the points of the ice tongs, but this did not occur. A double plaster of Paris spica was put on including the ice tongs and extending below the knee on both sides.

When the traction upon the foot was released, the femur was thus perfectly controlled and the final manipulation consisted of wrenching the foot, which was in fixed equinus up to a right angle with the leg. The patient made good progress without any postoperative complications whatever. He was healed and discharged from the hospital in a caliper splint in October.

I saw this patient again in February, 1928. When he was seen in bed the past summer, the patient had weighed one hundred and sixty pounds. When seen in February the next year, he had gained seventy pounds, and, while he was walking rather well with crutches and a caliper splint, his great increase in weight seemed to make it inadvisable for him to attempt to bear full weight on the limb. On account of loss of bone substance there was still a shortening of more than one inch. The exact amount was not accurately determined at this second examination. X-rays of the condition at the time of operation and a few months later are shown. (Figs. 34 and 35.)

The following is submitted as another illustrative case:

Case 14.—H. F. F., male, aged forty-one, was thrown from a wagon and caught between the wagon and a tree when a team of horses became unmanageable. (March 17, 1927.)

A physician was called and found a compound comminuted fracture at the lower end of the left femur. The patient was brought at once forty miles to the hospital, and I saw him on the operating table. No roentgenograms were taken, as the damaged parts were in full view on account of the compound injury.

Traction was applied immediately to both feet in a manner previously described. Full length of the injured limb having been obtained and the knee having been supported by overhead slings on the traction table, the

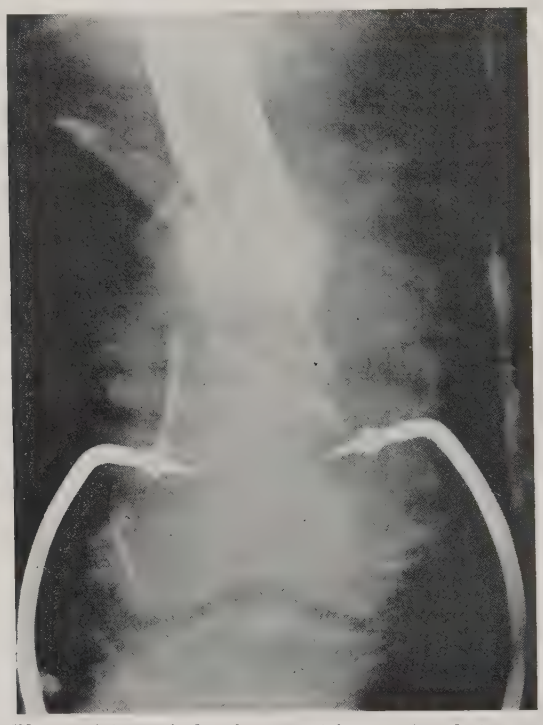

Fig. 36.—The position of the femur with traction being maintained by ice tongs. These ice tongs were inserted into the bone and the cast was applied while length was being maintained by a muslin bandage about the foot on the traction table. This has already been explained in the text. When the plaster, including the ice tongs, had set, the muslin bandage about the foot was released, and the foot and leg were included in the cast in a relaxed position.

Figs. 36-41 reprinted from *Am. J. Surg.* 4: 465-485, May, 1928.

wound was cleaned up as carefully as possible. Some damaged tissue and foreign material were removed. Attached bone fragments were permitted to remain. The popliteal space was widely exposed, all the vessels being visible as well as palpable. There was no damage to any of the principal vessels or nerves.

Full length and exact position of the femur fragments as to rotation having been obtained on the traction table, the wound was wiped out with tincture of iodine and alcohol and then gently packed open with vaseline gauze. The entire wound area was covered over with vaseline gauze and a dry sterile pad. Ice tongs were inserted in the condyles of the femur as shown in Fig. 38. A double plaster of Paris spica was put on with the ice tongs embedded in the cast.

From this time forward for six weeks nothing was done. At the end of that time a window was made in the cast, the ice tongs were removed, and a new dressing was put on. The wound was almost healed. A second dressing was done four weeks later, ten weeks from the time of injury. At this time the cast was removed and good consolidation of the fragments had taken place. A single spica was applied. The single spica was left on until June 1, at which time the cast was removed and a ring caliper knee splint applied (Fig. 41).

The roentgenograms shown in Figs. 37 and 38 were taken July 7, approximately four months after injury. Sound healing of the wound had continued, and there was firm union with full length in good position. Knee joint motion was begun for the first time. It is to be noted that there were no postoperative antiseptic dressings. In ten weeks only two dressings had been done.

On October 4, the patient was asked to come to the office for the photographs shown in Figs. 39, 40, and 41. Fig. 39 shows the patient in the caliper splint. Fig. 40 shows full weight bearing on the injured limb without additional support. Fig. 41 shows the amount of knee motion, seven months from the time of injury.

This is the routine method in our cases of bone and joint infection. Both the operation and the after-care are simplified to the greatest possible degree, and the results both in our hands and in the hands of others who are applying the method have been almost without exception exactly as they have been in this case.

Two additional illustrations are offered with legends to answer certain questions. I have been asked repeatedly about the propriety of applying a closed cast to a recent fracture. It is sufficient to say that it is the ideal treatment if the other conditions specified—reduction and asepsis—have been observed. With the wound cleaned up and the fracture reduced and dressed by the method that we have described, there is not only no swelling and no discharge but no pain or discomfort, as a rule. Pain, if it occurs, usually means failure to reduce and control the fracture. Swelling may mean the same or constriction by

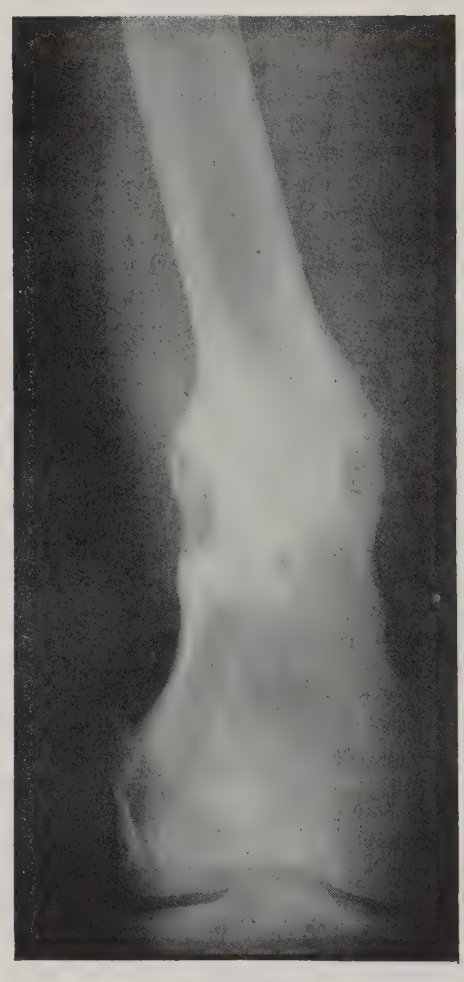

Fig. 37.

Figs. 37 and 38.—The appearance of the femur at the end of three months. Firm union has occurred with the fragments in good position. The compound wound on the outer side of the thigh was entirely healed with only one dressing which was done at the end of six weeks. The ice tongs were removed at the time of the six weeks dressing. There were no inflammatory complications whatever, either on account of the compound injury or on account of the use of the ice tongs. At the time when the cast was removed, in twelve weeks, the wound was found to be soundly healed, the cast was left off, and a caliper splint was applied.

a too tight cast. Discharge usually means infection, and it is rarely profuse *unless secondary inspections, dressings, etc., have been done.*

Fig. 38.

The working of the Orr method in the treatment of compound fractures should be apparent from these cases. The principles are those stated at the end of our discussion of

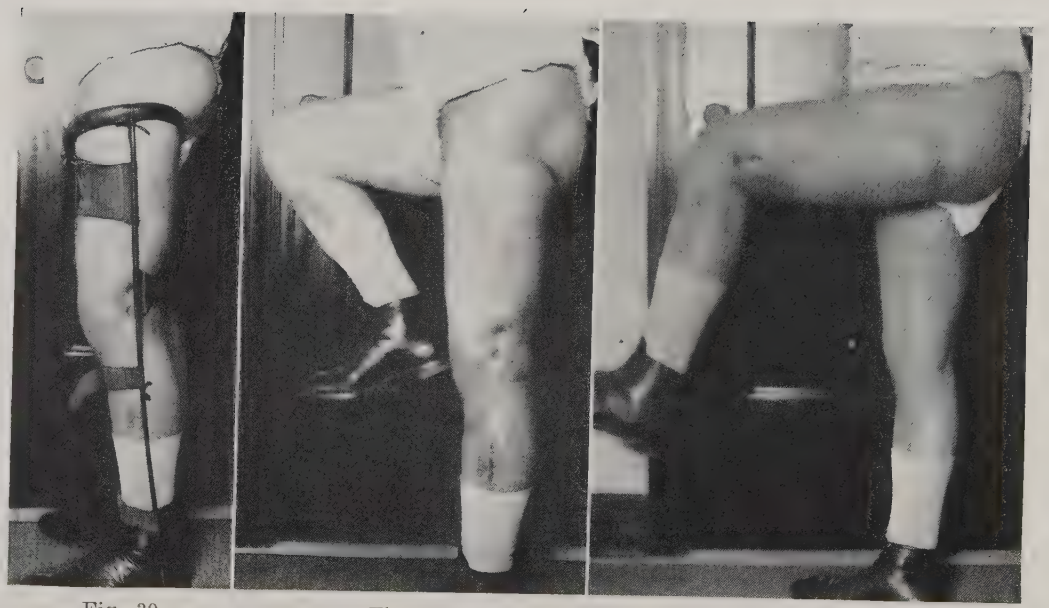

Fig. 39. Fig. 40. Fig. 41.

Figs. 39, 40 and 41.—The condition of the patient's extremity at the end of about five months. First, in caliper splint, then with weight-bearing and, finally, showing the amount of knee motion —almost 90 degrees. This has improved somewhat since that time.

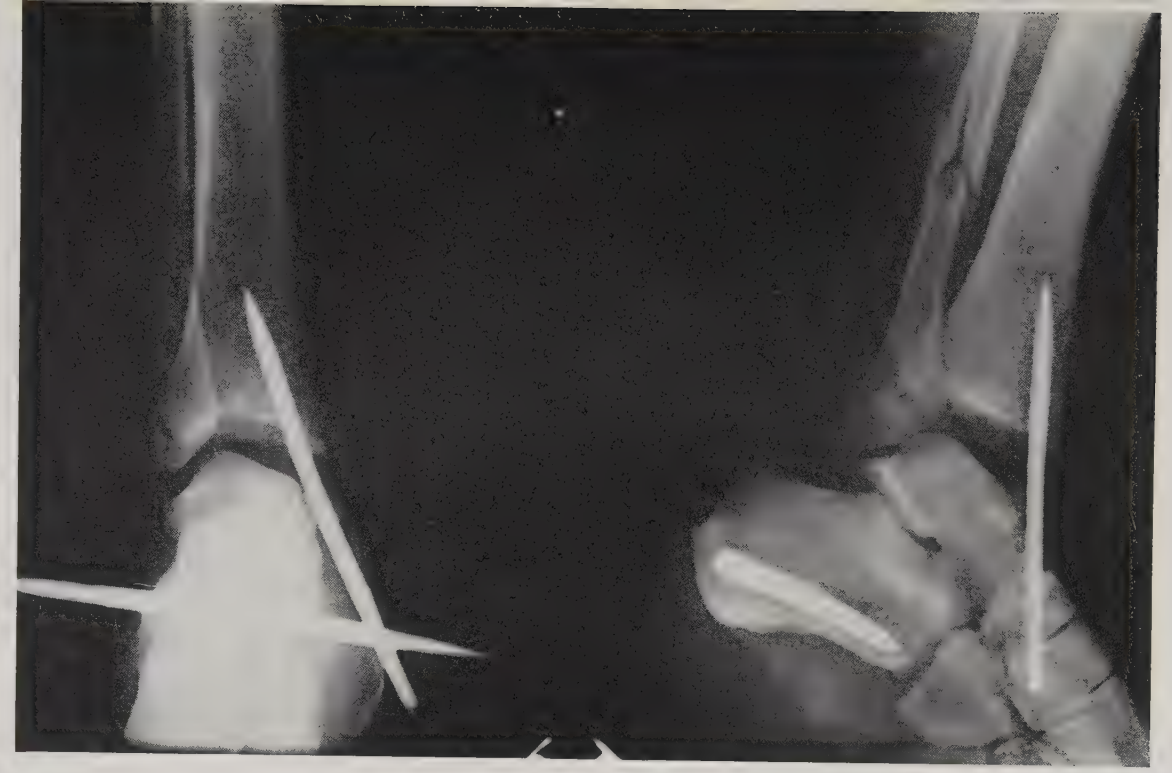

Fig. 42.—This patient, aged eighteen, weight 265 pounds, fell about 8 feet and sustained a compound fracture of the ankle. She came more than one hundred miles to the hospital, sitting upright in a small car. She was placed at once in the cast shown in the illustration, with one pin through the heel and another through the lower tibial fragment to fasten it to the upper fragment. At the time of injury there was not only a comminuted fracture but a fracture dislocation with extreme displacement of all the parts. The condition of the ankle at the end of two weeks is shown in the above illustration.

osteomyelitis; the modifications are those necessary to the unique problems of fracture treatment. It may not be out of place, here, to recall the advantages offered to the surgeon and the patient by this method.

Older methods, as their records show, were characterized by defects and failures which included suffering, expensive treatment, a large staff, a large percentage of failures, and too many deaths. The Orr method, combining

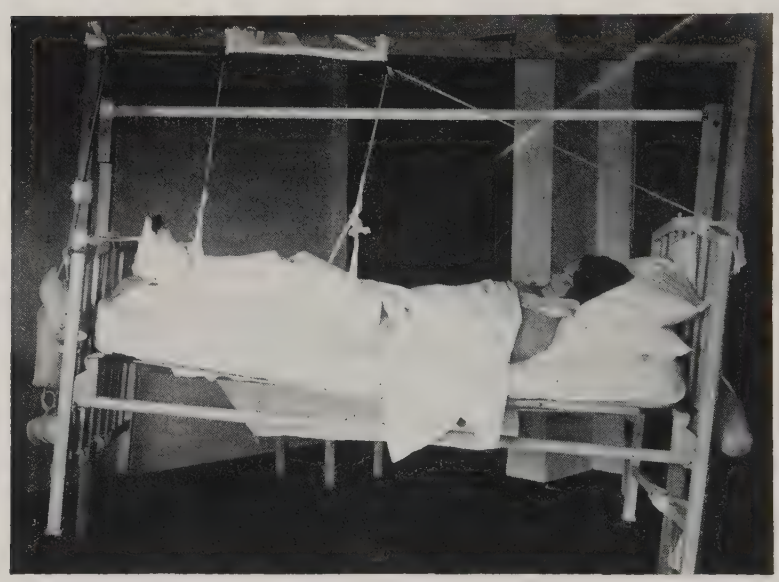

Fig. 43.—Same case as shown in Fig. 42. There were no complications whatever. The pins were out in four weeks, and healing was not delayed either because of the compound wound or of the fracture. The second cast was off at the end of twelve weeks.

the proved virtues of primary attention with the orthopedic needs of the patient and a "let alone" policy in after-treatment, avoids most of these shortcomings. The first operation sees the wound cleaned and the bones immobilized in correct position. What follows is comparatively simple, unless exceptional complications arise. There are no complicated irrigations or dressings, a large staff is not

required,—no one, in fact, but the doctor and the patient's nurse,—the patient is at rest and free from frequent painful dressings, and, in a large majority of cases, the fracture heals normally and successfully with a minimum of deformity or complications. In addition to such considerations, it may be added that the treatment is on the whole less expensive in that the period which the patient must remain in the hospital is shorter and the period of convalescence briefer than is usual.

One point in the changed method of dealing with compound fractures, osteomyelitis, and infected wounds may

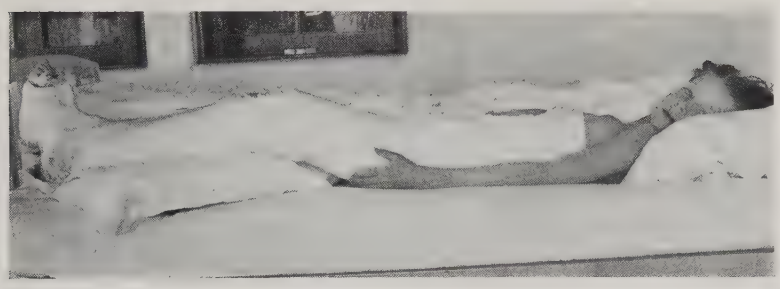

Fig. 44.—This patient is shown to call attention to one point in regard to which inquiry is frequently made. He had a severe compound fracture of the tibia and fibula involving the ankle joint. He was placed in the plaster spica shown above within about an hour following the injury. A pin through the calcaneum was embedded in the cast to maintain length and to prevent rotation of the foot in the cast. Another pin was driven through the lower tibial fragment and into the shaft of the tibia to control the small lower fragment in correct position. The outer end of this pin was also included in the cast.

be alluded to. In dealing with all such cases in office practice as well as in the hospital daily dressing has been the rule. Even when the needs of the wound have apparently not required it, the daily dressing has been done for "inspection" of the wound. I have demonstrated, I think, that the daily dressing is not only unnecessary but that it disturbs and delays healing in most cases. There is a point of great importance for the liability companies in compensation injury cases.

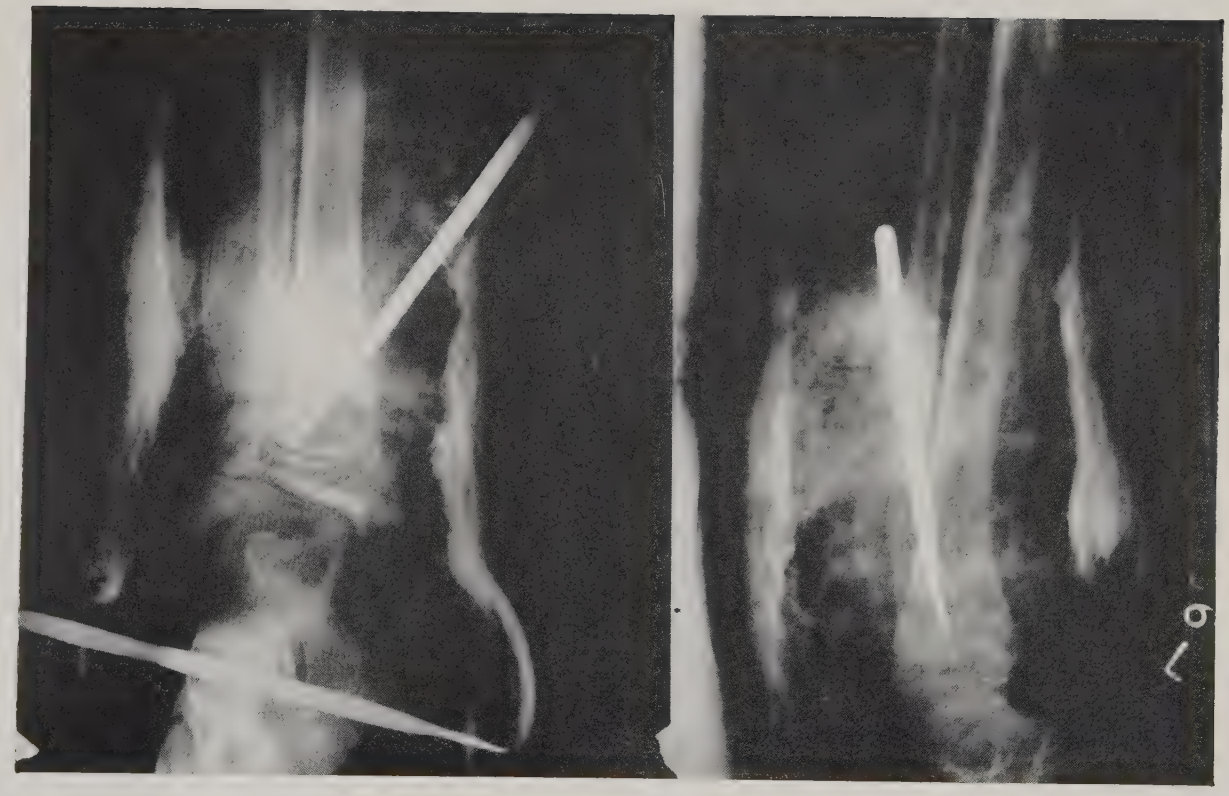

Fig. 45.—On about the third day this patient (shown in Fig. 44) had a rise of temperature, and it was suspected, of course, that an infectious complication might be developing in the fracture area. This is usually considered an indication for removal of the cast or at least for the opening up of the cast and the institution of so-called antiseptic treatment. I believe that it is this "opening up" and the subsequent dressing that leads to most of our serious infections in these cases.

In this case, after three days of rise of temperature, the pin through the tibial fragment (not the heel) was removed on the fifth day without making a window in the cast. The patient's temperature dropped to normal, the compound injury and the fracture continued to heal without further complication of any kind.

An excellent anatomical and functional result was obtained with a single dressing and a cast [illegible]

It might seem an uncalled for bit of extravagance that such claims for a new method have been set forth as they have in this and the previous chapter. Other methods have met with equal success in the case reports of their originators; is there any assurance that the Orr method will fare better? But it is precisely this that it will do: and it is another of the advantages of this method that it is suitable for employment by general surgeons everywhere. The closing pages of this book are devoted to proving this assertion.

CHAPTER V

Clinical Results

It is commonly asserted that a new mode of surgical procedure succeeds only in the hands of its originator. This has been urged as an objection to the method outlined in this book. It may be observed, however, that the "Orr Method" calls for neither special apparatus nor unusual skill; it is well within the range of any surgeon who conforms to the well-recognized principles of surgical practice. The technic required with this method, even where compound fractures—early or late—are involved, is much less difficult than most of those encountered in the surgical literature. Such difficult technical performances as Lane plating, Putti traction devices, and even weight and pulley traction combined with ice tongs and Balkan frame suspension, are almost never required. Only a certain dexterity in the use of moleskin traction, plaster of Paris, and skeletal traction devices sometimes included in plaster of Paris casts is essential; for these appliances are not only comparatively simple and easy to use, but they are also more effective than other splints and traction devices in insuring more permanent length, correct position, and immobilization. Aside from such considerations, however, the fact that other surgeons have been able, working under different conditions and with different backgrounds of training and experience, to employ the Orr method successfully, seems to point toward the possibility of using it universally. Since I have summarized the chief points involved in my method and discussed some of the specific objections urged against parts of it, I shall now bring forward a number of cases in which my method has been used by other men in order to demonstrate the results other

surgeons have already achieved. My comments on these cases will illustrate various points connected with the method, as particular cases present particular opportunity for special comment.

The Orr method is easiest discussed when divided into a series of steps. Such a division proves of value when criticism arises and when a special case under discussion presents features to be commented upon. A summary of the more essential components of the method would include:

1. Primary extensive osteotomy.
2. Primary asepsis or antisepsis.
3. Provision for adequate drainage—wide open sterile nonabsorbent packs to depth of infected region.
4. A postoperative dressing which protects the wound and precludes reinfection; dressing not changed for some weeks.
5. Avoidance of antiseptics and chemical irritants in after-treatment of the wound—preventing reinfection.
6. Immobilization—rest in the correct anatomic position; the first precaution in fracture cases.

A consideration of the objections to some of these parts or steps of the Orr method is of present interest.

It has been urged, in connection with the radical type of osteotomy described here, that it is wrong to operate upon a patient with acute osteomyelitis before the formation of sequestrum and involucrum. In cases where suppuration occurs we have been taught that drainage may be provided for; but if there is no actual sequestrum, procedure beyond drainage should be avoided. That this practice may be wrong, however, is revealed not only by experience but also by a consideration of the origin of sequestrum.

Sequestrum seems to occur because of inadequate drainage. The extensive death of bone that leads to the formation of large sequestra seems to result from the spread of an original infection which has not been adequately drained, so that in acute cases and even in early chronic cases,

sequestration may be avoided by thoroughness in drainage. The primary operation should be the only one, if possible; and since this is true, it may be admitted that in some cases, particularly of late chronic osteomyelitis, it is better to await the formation of sequestrum.

A second objection is often made that the prolonged immobilization advocated here is unnecessary and even injurious in producing muscle atrophy, bone atrophy, and joint stiffness. The cast, moreover, it is said, may cover up and delay the discovery of the development of another focus of infection in the same or in a neighboring bone. On the other hand, we are told, there is no serious suffering from muscle spasm. Those who have tried the Orr method have noted with satisfaction that this treatment by rest with the member in its correct position does prevent muscle spasm where other methods do not. That a cast will conceal other developments is unlikely. If the method has been used correctly, there is little possibility of infection by spreading from the original focus; if new infections appear, the symptoms will be apparent in the patient's temperature and elsewhere as in any original case.

The objection that immobilization produces stiffness does not hold in the experiences of those who have tried the Orr method. Dr. Albee very definitely says, "Immobilization does not produce permanent atrophy. Pain for lack of immobilization is more likely to do so, for pain causes continuous spasm of the muscle, and this produces atrophy. Many times efficient immobilization, if proper physiotherapy is carried out afterward, will prevent permanent stiffening of the joint, rather than produce it."[1] Not only pain and its consequences, but motion is productive of stiffness and ankylosis. And in many cases stiffness and atrophy are caused, not by immobilization, but by the extension of infection into the joints and into the structures about the joints. If an infected region is properly drained, and the extension of infection thus prevented, it does not

[1]Albee, Fred H.: Am. J. Surg., New Series. 4: 482, May, 1928.

matter how long the cast is left on; the amount of stiffness will only be as much as is caused by inflammatory adhesions, bony or otherwise.

Although it is a rather trivial point, it may be well to explain a seeming inconsistency regarding the use of antiseptics. The technic described in these pages calls for the use of tincture of iodine and alcohol; yet there are a good many places in the course of this discussion where one might get the notion that antiseptics should be dispensed with entirely. The point to be got is this: that antiseptics are useful in providing primary antisepsis, but that where they are employed otherwise, as in daily dressings, they are not effective, partly because of their limited efficacy and their early dissipation, but mostly because the opening of the wound itself to admit the antiseptics is distressing to the patient, deterrent to the healing process, and conducive to secondary mixed infections. When we recall that it is the surgeon's function not to cure infection, but to provide conditions favorable to cure by natural processes, we see the supreme worth and necessity of rest.

Many who have observed the after-care of patients treated by the Orr method have been disturbed by the odor which arises from the wound which has not been dressed perhaps for some weeks. Experiences vary here. It may be said that if primary asepsis or antisepsis has been achieved, there will be little or no odor even in a dressing left untouched for several weeks. It has been the experiences of others that the odor, though it may be discernible, is not offensive. Dr. Henry has the following to say:

"The odor is due to the secretions which become absorbed by the wadding that is present under the cast. The patient does not complain of the odor, but it is sometimes quite noticeable to those who are visiting the patient. In a great majority of cases we have found that the odor is not very prominent, and usually it is not noticed before the tenth or twelfth day. Occasionally it is found that the discharge is enough in amount that it trickles from the

end of the cast, although this does not happen often. Neither the presence of odor nor the presence or amount of discharge should be any source of worry if the temperature remains normal and if the patient is otherwise comfortable.''[2] In any event, if it is a choice between rest and disturbance to remove odor, it is surely better to choose the former.

If there have been these objections to the method herein described, there will doubtless be others. And it may be admitted that cases will arise in which the surgeon will have to depart from one or more of the details of this treatment. At the same time it must be remembered that a technic such as this does lend itself to certain standardization, and that the rank and file of surgeons who may not have had the special opportunities and peculiar experience of others may run considerable risk in departing from a technic that has given consistent results. The rest of this chapter is given over to cases of surgeons who are using the Orr method. These cases should indicate that the method works in the hands of others; and they will serve also as examples by which I may point out the various phases of my method for elucidation or other comment.

Although a number of broad surgical principles have been discussed at length in these pages, it has perhaps been the orthopedic aspects of the method that have drawn the most comment; and the orthopedic phase is the more important. For this reason, it is not surprising that the first surgeons to be attracted to the new technic were orthopedic surgeons who became interested because of what may be called the ''orthopedic viewpoint'' involved. Among the first to interest themselves in the Orr method were Drs. F. J. Gaenslen, of Milwaukee, and Ellis Jones, of Los Angeles. Drs. Arthur Steindler, of Iowa City, and Melvin S. Henderson, of the Mayo Clinic, are others who have

[2]Henry, Myron O.: The Orr Method in Treatment of Chronic Osteomyelitis, Journal-Lancet. **18**: 240, June, 1928.

taken up the method. To dispel the suspicion that my enthusiasm for my own method may color what I have said, the cases of some of these and other surgeons from their own clinics and in their own words are cited as additional, more disinterested evidence. My explanatory comments, of course, represent my own reaction to the cases.

One of the most interesting applications of the treatment of infected bone wounds by rest is to be found in compound injuries and osteomyelitis of the tarsus and adjacent portions of the foot and ankle. One of the first cases of osteomyelitis treated by Lister, using the antiseptic method, was one of the tarsus. The foot healed in a most gratifying manner and afforded a striking contrast to the results in similar preceding cases.

Even now in this class of cases amputation or severe disability has been the rule, because of customary treatment by wet antiseptic dressings and the extensive incisions that are commonly made in an effort to establish drainage of the foot, ankle and leg; also there is usually failure to apply a cast or any mechanical device for the maintenance of correct position of the foot and leg.

Some of the most gratifying results obtained by the application of the principle of rest to wounds and infections of this sort have with us also been obtained on the foot. Adequate drainage in any stage of compound or infected fractures with the foot maintained in correct position in plaster has given the most gratifying results. In this way healing in correct position in a very short time can be obtained, and although there is a certain amount of bone deformity, the patients have been found to have useful and painless extremities.

Two striking examples of this class of wounds are found in the two cases following of which the first is mine and the second Dr. Arthur Steindler's. The first follows:

Miss E., a nurse, aged twenty-one, developed an acute inflammatory condition in the left foot during January, 1923. The foot was immediately incised, but local and general sepsis progressed. Further incisions were made

in all parts of the foot and leg following the tendon sheaths and fascial compartments as is customary in such cases. I saw her at the end of the seventh week. She was in a serious condition with an enormously swollen leg which had been freely incised and continuously fomented or irrigated for weeks. She had a marked hip, knee, and ankle contracture deformity. The foot and leg were badly macerated and very foul because she would not tolerate any cleaning up measures. X-ray at this time showed a destructive bone lesion involving the tarsus which had apparently never been drained. It is worthy of mention that at this time the pain was so severe that she was receiving one-fourth grain of morphine every four hours.

She was taken at once to the operating room and a thorough drainage operation into the tarsus was done. A good-sized abscess cavity was found and cleaned out. The wound was packed well open with vaseline gauze and then the hip and knee were straightened out. With a little force the foot was brought up to a right angle with the leg. All of the other open incisions were merely wiped with iodine and rinsed with alcohol. A sterile sheet cotton bandage was put on over the gauze dressing and a long cast was put on. The patient was put to bed with the leg in suspension and traction. For the first day or two she still clamored for morphine but received none after the third day. At the urgent request of her previous surgeon, a dressing was done on the tenth day. There was no discharge and the wound looked healthy. None of the other incisions gave the slightest trouble. This patient was in a cast for about three months. Then a posterior iron was put on. The wound was entirely healed and has remained so. There is a little equinus and varus deformity, but with a special shoe there is no disability whatever. For the past two and one-half years she reports that she is able to do as much on her feet as she ever did.

Upon opening into an osteomyelitic abscess in the tarsus one finds himself facing various open joints. At first glance it seems that to pack such an abscess cavity even lightly with vaseline gauze will be to dam pus back into these articulations. It has been found, however, that such a pack not only does no harm, but that the amount of further discharge inside the cast is very small and healing rapid and complete as in this case.

Dr. Arthur Steindler, of Iowa City, reports a similar case as follows:

Case.—Helen McG., aged eighteen years.

Spina bifida occulta; claw foot. December 27, 1922.

Examination showed congenital claw foot, bilateral, very marked; congenital scoliosis, lumbosacral tuft of hair; sensation apparently normal; flexion of toes very weak. Knee jerk sluggish.

It is a third or fourth degree club foot with heads of metatarsals protruding very distinctly. Callosity over fourth toe of right foot. Contraction

of extensor tendons very severe. Operated upon January 2, 1925. Open tenotomy of extensor of fourth toe, right foot. Wedge-shaped resection of head of basal phalanx and head of middle phalanx.

Jan. 8, 1923: Superficial infection, slowly being taken care of.

Jan. 16, 1923: Discharged. Wound entirely healed.

Apr. 11, 1923: Returns for second operation.

Apr. 15, 1923: After four days preparation, foot was operated upon. *Left foot*: Dissection of extensor of big toe and implantation into 1st metatarsal. *Rt. foot*: Same. In addition resection of heads of second and third metatarsals and bunion operation on big toe. Casts applied.

Apr. 24, 1923: Patient complains of slight pain in feet and had slight fever. Casts removed. *Left foot:* Healed by primary union. *Rt. foot:* All incisions healed but one on dorsum of foot from which pus is exuding. All stitches removed. Wound laid widely open and hot boric dressings applied. W. B. C. 14,000. Infection not yet controlled.

May 7, 1923: Three incisions made. One on the dorsum of the foot and the middle one over the fifth metatarsal where a pus pocket is encountered. One on the dorsum between the first and second metatarsals. Small wicks inserted in all wounds. Hot boric dressings.

May 9, 1923: An additional incision made on dorsum of foot opening another pus pocket.

May 11, 1923: Night of tenth very stormy. Wound is dressed three times.

May 12, 1923: Night very stormy. Considerable pain. Amputation is considered. W. B. C. 21,000.

May 13, 1923: Less pain, more drainage. Improved. Wound is less glassy in appearance. Right ankle free. Vomiting.

May 15, 1923: Taking more fluid. Is being given champagne; drainage free.

May 16, 1923: Temperature 99.8° F. General appearance much improved.

May 18, 1923: Temperature suddenly up to 104°. Additional dorsal incisions made.

May 19, 1923: Temperature 104°. Patient very septic. W. B. C. 15,000.

May 27, 1923: Patient somewhat better. Question of amputation seriously considered.

June 5, 1923: At the suggestion of Dr. Orr, in his presence a radical operation was performed. A large opening was made down to the bone on dorsum of foot. The cuboid and some of the cuneiform was resected. This was loosely packed with vaseline gauze and a plaster cast was then applied reaching from the toes up to the hip. The foot is suspended in a Bradford frame.

June 9, 1923: General condition better. Pulse goes as low as 92 and temperature goes down in A.M. now, although it still rises in P.M. to 103°. Taking fluids much better.

June 19, 1923: Temperature last few days has not exceeded 101°. General condition much better. Patient has obtained a good deal of relief from the plaster cast. The granulations in the cavity are healthier.

June 22, 1923: Improving. Temperature 97° to 102°.

June 27, 1923: Cast changed. Wound well and granulating. Pus is thick. There is a superficial slough under the knee. New cast applied in extension.

July 6, 1923: An abscess developed at the upper thigh. Pus evacuated by incision. Temperature drops to normal.

July 25, 1923: All three wounds look well. Thigh abscess still draining. Temperature has been normal last three days.

Aug. 13, 1923: Wound of tarsus filled out with granulation tissue. Knee wound healed. Abscess of thigh has ceased to discharge. Casts continued.

Aug. 16, 1923: Up on crutches.

Aug. 30, 1923: Temperature up to 102°. W. B. C. 18,000. Cast is removed and a small abscess found. Incised. Temperature drops to normal and stays so.

Sept. 15, 1923: Brace fitted. All wounds healed. Patient is discharged.

Nov. 5, 1923: Anklet fitted.

Apr. 9, 1924: Varus deformity of foot corrected. Cast applied.

Apr. 15, 1924: Uneventful recovery.

Oct. 1, 1924: Wrenching under anesthetic. Good correction obtained. Cast applied.

Aug. 10, 1925: Walking very well with only slight limp. Foot is entirely rigid. Dorsal scar slightly tender.

Aug. 18, 1926: Walking better than ever. Barely perceptible limp. Dorsal scar is heavy. No tenderness is present.

This was the first case operated upon by Dr. Steindler in which my method was attempted. Septicemia in a severe form was present at the time of operation. Some metastasis of sepsis had already occurred. It was, and is, my opinion that an amputation—the still common practice in such cases—would have caused the death of the patient. The very seriousness of such a case has usually led us to take off casts, as at the beginning of this case, and begin dressings that are quite as likely to aggravate as to relieve the condition. It is my opinion that in such a case provision for early drainage without further infection by so-called antiseptic dressings and without disturbing the cast, except perhaps for a window, is treatment enough.

Dr. F. J. Gaenslen, of Milwaukee, was one of the first and most enthusiastic users of the Orr method. His attitude may be seen in the following letter and report of cases:

Dear Dr. Orr: . . . . . .

I am sending herewith a résumé of all of our cases at Milwaukee. This does not include the Madison cases. I could probably double or triple this list by adding the Madison cases.

(Signed)
F. J. Gaenslen.

Case 1.—T. S., aged thirteen years. Left tibia. Onset: about Sept. 5. 1924.

Deep defect close to lower epiphysis with defect shelving properly in upward direction toward the knee, but abrupt deep perpendicular wall toward site of lower epiphysis.

October 21, 1924; sequestrectomy, vaseline dressing, cast. This patient had six vaseline dressings and cast changes. The wound healed in six months.

Case 2.—L. R., aged twenty years. Osteomyelitis of right tibia. Onset in 1923, following scarlet fever.

Operation Sept. 21, 1926; sequestrectomy, vaseline dressing, and cast. This patient had four vaseline dressings and cast changes. Entirely healed on Jan. 4, 1927. In hospital four days.

Case 3.—M. K., aged twenty years. Osteomyelitis of right tibia. Onset in 1923, following scarlet fever.

Operation Sept. 21, 1926; sequestrectomy, vaseline dressing, and cast. This patient had four vaseline dressings and cast changes. In hospital four days.

Case 4.—M. E., aged five years. Osteomyelitis of left fibula. Onset: December, 1925.

Operation March 22, 1926; sequestrectomy, vaseline dressing, and cast. This patient had two vaseline dressings and change of casts. Entirely healed on May 14, 1926. In hospital three days.

Case 5.—A. L., aged twenty-five years. Osteomyelitis of left femur. Onset: about 1923.

Operation September 29, 1925; radical operation, incomplete on account of danger of fracture. This patient had two vaseline dressings and cast changes and then a splint was applied.

Wound healed by March, 1926. Small sinus draining up to September, 1926. No later report. Probably still draining. In hospital fifty-six days.

Case 6.—H. S., aged eight years. Osteomyelitis of right tibia. Onset: August 21, 1923.

Operation October 17, 1923; sequestrectomy, vaseline dressing, and cast. This patient had six vaseline dressings and cast changes. Wound healed in six months. In hospital four days.

Case 7.—W. B., aged two years. Osteomyelitis of right tibia. Onset: about November 15, 1924.

Operation April 11, 1925; sequestrectomy, vaseline dressing, and cast. This patient had four changes of casts and vaseline dressings. Final healing about August 10, 1925. In hospital two days.

Case 8.—E. A., aged five years. Osteomyelitis of left tibia. (Our first patient.) Onset: about July 15, 1923.

Operation September 7, 1923; sequestrectomy and curetting of abscess, and vaseline dressing. Eight dressings, no plaster cast applied. Final healing occurred about October 12, 1923. In hospital two days. Technic not followed as to fixation by cast.

Case 9.— W. R., aged seven years. Osteomyelitis of os calcis. Onset: uncertain.

Operation January 7, 1926; sequestrectomy, vaseline dressing, and cast. The cast was split at the end of two and a half weeks, three dressings. Final healing about March 7, 1926. In hospital four days.

Case 10.—C. W., aged forty-five years. Osteomyelitis of right humerus. Only small scale-like sequestra—not an extensive lesion. Onset: about March, 1924.

Operation April 22, 1924; vaseline dressing and cast. This patient had three dressings. Final healing about June 9, 1924. In hospital twelve days.

Case 11.—Mrs. G. Osteomyelitis of left tibia. Deep lesion close to lower end of tibia, shelving edge impossible, abrupt perpendicular lower wall to defect. Onset: March, 1924.

Operation June 18, 1926; vaseline dressing and cast. In hospital seven days. This patient had 9 cast changes and dressings. Wound not entirely healed March 16, 1927.

Case 12.—D. W., aged ten years. Osteomyelitis of left tibia. A typical case. Several lesions healed without surgery, but the left tibia was otherwise a typical lesion with sequestra and usual type of pathology. Onset: about March, 1926.

Operation April 9, 1926; plaster cast and vaseline dressings. This patient had two cast changes and vaseline dressings. In hospital seven days. Healed May 28, 1926.

Case 13.—M. H. Osteomyelitis of os calcis, a typical case. Crushing injury of heel with late scale-like sequestra. Final healing delayed because of glycosuria probably blood vessel changes and scar tissue. Onset: about December, 1923.

Operation February 12, 1924; sequestrectomy, vaseline dressing, and cast. This patient had one change of cast and several dressings. In hospital for three months for medical treatment. Last note, December 22, 1924, small transverse area not healed.

Case 14.—K. H., aged ten years. Osteomyelitis of left humerus and of left ulna. Onset: April 10, 1926, infected compound dislocation of elbow. This was a desperate case.

Operation: radical operation on ulna August 13, 1926. On humerus, August 31, 1926. Vaseline dressing and cast. This patient had three cast changes and vaseline dressings. Ulnar wound healed October 1, 1926. Wound over humerus healed with exception of small sinus at elbow on December 24, 1926.

Case 15.—Osteomyelitis of right ulna and right radius; ununited fractures of both. Onset: May, 1924, following open operation for fractured ulna and radius.

Operation February 5, 1925; sequestrectomy, vaseline dressing, and cast. This patient had three cast changes and vaseline dressings.

Healed on March 23, 1925. Bone ends cleaned up on February 3, with the idea to prepare the forearm for bone graft at later date. Union avoided necessity of bone graft.

Case 16.—M. L. Osteomyelitis of right humerus with ununited fracture. Onset: September, 1925, following an open operation for fracture of humerus.

Operation November 27, 1925; sequestrectomy, vaseline dressing, and cast. This patient had two changes of cast and vaseline dressings.

Healed on January 4, 1924. Bone graft for nonunion was successful at a later date.

There are several extremely interesting points that develop in a study of Dr. Gaenslen's cases. Dr. Gaenslen in the beginning was uncertain about the necessity of cast fixation, especially in the latter part of treatment. At the present time, almost all of those who have had an extensive experience with the method are agreed that efficient protection of the wound and adequate immobilization of the part should go hand in hand until healing is practically complete. If there is an unhealed area or discharging sinus near a joint, the control of the part should be maintained not only until sound healing has occurred but until the patient is well past the danger of a relapse. From the earliest stages of development of this method also, Dr. Gaenslen has been interested in bringing out other points of value in the method to which I early called attention. These may be summarized again as being the prevention of postoperative infection, relief for the patient by avoiding frequent dressings, the shortening of the period of hospitalization, the saving of time, material, and labor; the avoidance of septic metastasis because of nondisturbance of the wound surface, and better end-results.

Emphasis upon all the points appears at different places in Dr. Gaenslen's report. The very short period of stay in hospital even after severe operations appears in nearly all of his cases.

At first Dr. Gaenslen was inclined to change casts and do dressings oftener than he is now. I have observed that even in my own practice there are times when because of demands of the patient or of the patient's friends or sometimes on account of the curiosity on the part of the family doctor I am induced to make changes of dressings that are entirely unnecessary. This is a tendency that must be resisted. Dressings should not be changed except for surgical reasons.

It must be observed that as one develops in experience with the method these changes become less frequent so that many patients may be left from operation to healing without any change whatever.

Dr. Gaenslen has employed vaseline instead of vaseline gauze for filling the wound, using a fairly heavy vaseline mass. There is certainly no objection to this. A mass that will keep the wound wide open and that will not melt or run out of the wound at body temperature is what is essential. The weight of the evidence of Dr. Gaenslen's reports, however, certainly seems very great. The variety of cases that he has treated successfully by my method will be of interest, both as to kind and as to severity, to any surgeon who is confronted by these difficult problems.

The following are nine cases reported by Dr. E. A. Rich, of Tacoma, Washington. Dr. Rich writes:

Dear Dr. Orr:

Enclosed please find a synopsis of nine cases of the pack method in osteomyelitis. If you want anything further by way of data just command me. I have several unfinished cases under treatment that you can have reports on if desired. I can truly say that in my hands the method gives far better and more permanent results than any other that I have used in such infections.

(Signed)

March 17, 1928. E. A. Rich, M.D.

Case 1.—B. J. T., male, aged eighteen years.

Diagnosis.—Osteomyelitis of upper shaft of tibia. Two sinuses.

Duration of Disease.—Three months, three days.

Origin.—Boil on abdomen.

Treatment.—(Had been treated for typhoid fever.) Radical opening of upper two-thirds of tibia. Two large sequestra about 3 inches long removed. Endosteum irrigated with iodine wash. Bone and wound packed with vaselined iodoform runners. Cast applied. Spica to toes.

Dressings: outer dressing foul and changed through window on thirtieth day. Wound healed by protrusion and "let alone" on the seventy-first day.

End-result.—Complete repair. Man worked in smelter on seventy-second day. Elapsed time since healing—sixteen months.

Case 2.—Tom. T., male, aged twelve years.

Diagnosis.—Acute osteomyelitis of left tibia, left knee joint, and left femur.

Duration of Disease.—About five weeks.

Origin.—Mastoid disease.

Treatment.—Two incisions, first over full length of tibia and through knee, lateral to patella. Second lateral to upper half of femur.

Entire shaft of tibia from one epiphysis to the other was removed as it was detached from sequestrum. Knee joint found generally necrotic, full of pus, and partly ankylosed. Upper half of femur below trochanter was opened and several small sequestra the size of quarters were removed. All wounds were irrigated with iodine-aqueous solution and packed with vaselined-iodoform gauze. Double spica from nipples to toes applied.

First dressings made necessary by excessive drainage of femoral opening. Outer dressing *only* changed through large windows, third week.

Second dressing to site of first dressing and to tibial wound on fortieth day.

Tibial wound extruded packing in five months, twenty-one days. Entirely healed including knee in ankylosis seven months.

Femoral wound extruded packing about sixtieth day. Very slight drainage still persists (2 yr., 2 mo.) Leaves a mark on gauze dressing in two days.

Complications.—Twenty-five months after first surgery there developed a large abscess in left axilla. Opened, drained; healed promptly.

End-result.—One area, tibia, complete permanent healing of bone and soft parts.

Femoral area, healing with diminishing sinus.

In discussions of my method information is often desired with regard to tibial or femoral osteomyelitis involving the knee joint. Here, as elsewhere, the indications are for immediate adequate drainage,—before joint destruction if possible,—wide open packing, and the most perfect immobilization possible. I have had hips, knees, and ankles all movable after purulent complications in osteomyelitis of

the neighboring bones. If any septic destruction of the joint occurs, however (that is, of the articular surface), ankylosis is to be expected, and is on the whole rather to be desired. The patient who heals up after an extensive inflammatory trouble of this sort with extensive scarring about and into a joint is very liable to inflammatory recurrences if there is any considerable amount of motion remaining. (See my case, T. T., on page 87.)

There is another point also in connection with this case. That is with regard to the "diminishing sinus" that leaves a mark on the dressing every two days.

It has been the observation of many of us that we are disposed to abandon our plan of infrequent dressings toward the end of treatment and to allow the home doctor, the visiting nurse, or even the patient or his family to fall back into the old habit of daily dressings. This, almost always means new infection, more discharge, and complications that lead down to the bone. New bone infection with the need for another surgical procedure is quite likely to follow. The terminal dressings in such a case should be as far apart and as carefully done as at first. In this way they will lead to earlier and more certain sound healing.

Case 3.—Edw. H., male, aged forty-four years.

Diagnosis.—Acute osteomyelitis of humerus.

Duration of Disease.—Five weeks.

Origin.—Many abscessed teeth.

Treatment.—Teeth removed. Incision to humerus, upper half. Long groove made to medulla. Some pus present not under usual pressure. Spicules of bone removed. Wound packed with vaselined-iodoform gauze. Arm strapped to body. Complete healing with extrusion of pack in twenty-three days.

End-result.—Eighteen months since healing. No complications.

Case 4.—Albert S., male, aged twenty years.

Diagnosis.—Acute osteomyelitis of ulna, involving elbow joint.

Duration of Condition.—One month.

Origin.—Secondary to multiple superficial infections 1915-17.

Treatment.—Incision to ulna and into elbow joint. Removal of sequestrum, full diameter of shaft. Removal of head of radius (necrotic). Packing of wound and into elbow. Cast, finger tips and shoulder spica. No

changes of dressings during first month and a half. Healing of wound by extrusion of packing in eight and a half weeks. Complete ankylosis in good position of elbow.

End-result.—Complete bony healing.

Case 5.—Carol H., female, aged six years.

Diagnosis.—Chronic osteomyelitis of radius.

Duration of Disease.—Six months. Two primary operations by other surgeons.

Origin.—Uncertain.

Treatment.—Two incisions to radius; isthmus saved between two. Five inch sequestrum, full diameter of old radius removed. Involucrum solidly formed. Wound packed with vaselined-iodoform gauze. Cast from fingers to axilla with elbow at right angles. Let alone treatment followed.

Gauze extruded in three weeks from both troughs. Healing complete in four weeks.

End-results.—Now two and a half months since healing. Wounds entirely well and function of hand and arm normal.

The technic employed by Dr. Rich in his operation upon this patient (Case 5) is open to the objection that in order to secure healing a certain amount of infection will certainly have to be "healed in" in the medulla of the bone. I employed this technic in operating upon a physician about two years ago and failed to get a satisfactory result. This represents one of the "compromises" previously referred to; and while one may get a good result by such methods occasionally, they will often lead to failure.

Case 6.—E. D. N., male, aged sixty-four years.

Diagnosis.—Acute osteomyelitis of forefinger and one metacarpal, following colon infection.

Duration of Infection.—Five weeks. Incision had been made. Middle third finger had been amputated.

Findings.—Osteomyelitis. First phalanx of forefinger and second metacarpal.

Treatment.—Openings into palm of hand and to first phalanx of forefinger. Removal of sequestra only partly detached. Good exposure of medulla accomplished. Wound packed with vaselined-iodoform gauze. Outer dressing changed twice on account of excessive odor.

End-result.—Healing of both wounds complete in about three and one half weeks.

Case 7.—Elizabeth B., female, aged six years.

Diagnosis.—Osteomyelitis of tibia, sub-acute.

Duration of Disease.—Two months, sixteen days.

Origin.—Exanthema.

Treatment.—Had had opening by old method by another surgeon, four weeks previously. Long incision. Large elongated 5" saucer in tibia chiseled cut. No definite sequestrum found. Pus plentiful. Wound packed with vaselined-iodoform gauze. Cast, toes to nipples. "Let alone" treatment for five weeks. Then removal of cast and gauze extruded. Opening to wound left through soft parts which promptly granulated and epithelialized. Small sinus persisted in upper part of wound. Wound neatly healed in eight months. In this case, healing was delayed by a low grade infection in the soft parts and a skin eczema.

End-result.—Perfect x-ray and functional results.

Case 8.—W. J. H., male, aged twenty-two years.

Diagnosis.—Chronic osteomyelitis of os calcis.

Origin.—Fracture of os calcis and infection.

Duration of Condition.—Thirteen years. Interval of use for seven years. Recent incapacity three years.

Treatment.—Sinuses on either side of heel elongated into ample incisions. Thorough investigation of os calcis mass made at different levels on two sides. Removal of numerous sequestra. Packing with vaselined gauze. Plaster cast to knee. Dressings came out change of casts, repacked 3 or 4 times. Complete healing in three months.

End-results.—No recurrence after nineteen months.

Case 9.—George G., male, aged fifteen years.

Diagnosis.—Osteomyelitis of upper tibia and knee joint (knee flexed).

Duration of Disease.—Three years.

Origin.—Unknown.

Treatment.—Had had "radical" operations in Tacoma and Seattle (two times). Long anterior incision in upper third of tibia. Loose sequestrum removed. Wound washed with pure carbolic acid and alcohol. Knee forcibly straightened. Wound packed with vaselined-iodoform gauze. Cast, from nipples to toes. "Let alone" treatment used. One change of outer dressings. Complete extrusion of gauze with healing in twenty-five days.

End-results.—Is walking on leg now, three months after surgery. Complete cure of bone infection.

The results of the drainage and rest method in general are beautifully illustrated in these cases of Dr. Rich. It will be observed that some different technical details have been employed. I hope that in the preceding pages I have made it clear that it is surgical principles that I am concerned about rather than technical details. Accordingly this slight change need disturb no one. Dr. Rich's results are excellent and his selection of cases most interesting and instructive. I prefer a method of using antiseptics (if any) in which they are not brought into direct contact with the wound surface. That the use of some antiseptic

in connection with primary clean up or to keep down fermentation that causes odor may be desirable, is not disputed. Up to the present time, however, no wholly satisfactory plan for doing these things has been decided upon.

In connection with the last case (Case 9) attention is directed to another point which has previously been referred to: the correction of the knee which was found in flexion deformity at the time of operation is not only permissible but desirable.

We have all been told that manipulation of joints in fracture deformities in the presence of infection is to be avoided; in fact, are usually quite emphatically forbidden. It has been my custom for some years, in dealing with all such drainage operations, to perform any manipulations which are safe for the nerves and blood vessels in an effort to restore joints, fracture fragments, ligaments, muscles, etc., to positions in which they can resume functions as near to normal as possible. This is important not only as a measure to reduce ultimate disability to as small a degree as possible, but as a factor in the promotion of early healing. In performing manipulations for the correction of deformities at joints or at the point of fracture in compound fractures, one point, however, should always be observed: the injured part should be brought into as good position as possible with a single corrective movement and not by a series of "pump handle" movements.

The following communication from Dr. Emil S. Geist, of Minneapolis, is self-explanatory:

April 25, 1928.

My dear Dr. Orr:

We have used the Orr Method in the treatment of osteomyelitis for approximately two years. During this time we have taken care of somewhat over fifty cases of chronic osteomyelitis and two cases of acute osteomyelitis. Our results, so far, have been extremely satisfactory.

1. *Acute osteomyelitis.* Experience limited to two cases, in both of which the tibia only was affected. Typical cases in children. Typical Orr treatment. I will confess that after the operation both cases were watched with considerable trepidation. After Orr dressings, casts were applied, which

extended from the toes to the groin. Nevertheless, the temperature dropped promptly in both cases, and restitution ad integram promptly took place without sequestration.

Chronic osteomyelitis. Something over fifty cases treated with uniformly and enthusiastically good results. Four or five of these cases were complicated with adjacent joint infection. I have never had a group of osteomyelitis cases heal as rapidly and as pleasantly as this group did (in spite of the element of smell, which, by the way, is not nearly as bad as I had expected it would be).

I believe good end-results can invariably be obtained by your method if it is strictly followed. The two essentials, to my mind, are:

1. Thorough cleaning out and saucerization.
2. Complete fixation, including the contiguous healthy joints.

Of this fairly representative group of cases, I will briefly mention only two which stand out in my memory. The first case—a child ten years old with multiple osteomyelitis involving the right and left tibiae, and the left ulna and clavicle. On account of the fact that the child took the anesthetic nicely, and I had good assistance, the four above mentioned affected areas were operated at the same session, and Orr fixation dressings, including plaster casts to both legs, were applied. Four months after operation there was complete healing.

The second case was one of osteomyelitis and epiphysitis of the lower end of the tibia, following a compound fracture of the ankle, in a seventeen-year-old football player. There existed a suppurative arthritis in the ankle joint, and the case looked like one for amputation. On operation, the entire lower epiphysis of the tibia was found sequestrated and in fragments, together with osteomyelitic involvement of the lower end of the tibia. Two wide, anterior, longitudinal incisions were necessary to thoroughly clean out the joint. Following the operation, the usual iodine, vaseline, and plaster of Paris dressings were applied. The casts were changed every four weeks and Orr dressings renewed. Postoperative treatment covered a period of four months, during which the patient was absolutely comfortable, and at the end of which time complete healing had taken place with a stiff ankle in good position. Today, one year after healing, the patient is walking.

Fraternally yours,
(Signed)
Emil S. Geist.

It was my privilege to operate with Dr. Geist in October, 1926, upon the first cases that Dr. Geist treated by this method. One of the cases at that time (which Dr. Geist does not report) was that of an old man who had a chronic osteomyelitis of the first phalanx of the great toe. He had been in bed for some months and on several occasions. Amputation had been considered but not done on account

of the fear of a septic stump. It was suggested that if my method would benefit this case it would make a very convincing test. The phalanx was freely opened, packed, and a cast put on. Although the discharge was so free that there was oozing out through the end of the cast, no dressing was done for many weeks. The toe healed and at last accounts had remained well. Dr. Geist's two acute cases are typical as to onset, as to the surgeon's attitude toward the method, and as to the result.

Dr. Ellis Jones, of Los Angeles, has selected five illustrative cases for his report.

Case 1.—R. E. M., aged twenty-one years, was admitted to the hospital on June 20, 1927, because of a marked synovitis of the left knee joint secondary to an old chronic osteomyelitis of the entire tibia. The knee was aspirated, and the culture showed Staphylococcus aureus. The entire anterior portion of the tibia was removed from the tibial tubercle to within two inches above the ankle joint. The Orr method of dressing was used and a cast applied from toes to groin. The surgical convalescence was uneventful with a normal temperature after the second day. The cast was not disturbed for five weeks, at which time the packing was removed and the wound was found half filled with firm granulation tissue, slight amount of drainage, and the knee was negative.

The wound was repacked and a fresh cast applied which remained for a further period of three months, at which time the wound was found to be healed.

Case 2.—D. L. J., female, aged two years and three months, was brought into the office May 29, 1925, because of pain in the right knee. Three weeks previously she had a temperature of 104.4° F. which was diagnosed as acute infectious arthritis and "red throat." Two days later swelling of the knee was observed. During the week her temperature ranged from 102° to 105.4°.

After the second week she ran a normal temperature. Examination three weeks later showed expansion of the shaft of the right femur, lower one-third, marked adenopathy of the groin and with only thirty degrees voluntary motion in the knee joint. X-ray showed a small necrotic area over the lower internal end of the diaphysis of the femur just proximal to the epiphyseal line, with a thickening of the periosteum involving the posterior internal portion of the lower one-third of the shaft of the femur. A complete sequestrectomy was done followed by the Orr treatment. The original packing was not removed until one week from date of the operation. The leg has remained negative since that time.

So far as I know, Dr. Jones was the first to accept the suggestion as to the entire propriety of employing the

method of drainage and rest in what is variously referred to as acute, fulminating, or malignant osteomyelitis. The above is a perfectly typical case and a typical result in such a case, though Dr. Jones has not mentioned the double plaster spica cast which must always be employed. Drainage of the femur in such a case during the first few days will spare the patient septic metastasis and secondary lesions. Early drainage also, of course, greatly diminishes the danger of bone death, necrosis, formation of sequestrum and involucrum and all the other common sequelae. Another point of importance in early primary drainage is that by doing an aseptic operation and by omitting the postoperative dressings, the mixed infection complications that we have always had may be and usually are entirely avoided as in this case.

Case 3.—E. P., female, aged twenty-two years, was admitted to the hospital July 17, 1927, with a temperature of 105.8°. On examination this patient was found to have an acute osteomyelitis of the sternum, metastatic following influenza. X-ray showed evidence of osteomyelitis involving the manubrium with some extension of the process into the proximal end of the left clavicle. Immediate incision and drainage was done with the Orr method dressing. A blood transfusion was given on the fourth postoperative day. Her temperature ranged from 101° to 105.8° for one week postoperative. The blood culture showed a positive Staphylococcus aureus with leucocyte count of 44,800 and a count of 96 per cent polymorphonuclear neutrophiles. Two 25 c.c. injections of mercurochrome were given intravenously on alternate days. The dressings were not changed for two weeks, and only then because in delirium the pack was removed by the patient. There was a slight amount of drainage. Convalescence was uneventful after the first two weeks except for a persistent temperature running from 99° to 101°. On the sixty-ninth day postoperative the patient was taken again to surgery for a sequestrectomy. The entire anterior plate of the manubrium together with the proximal end of the left clavicle was excised and the Orr method for dressing the wound was used. The original packing was not removed until the wound was entirely healed.

A patient with an acute bone infection and a septicemia already established (one might better say a severe septicemia since many of them, if not all, really have a septicemia from the beginning) calls for the exercise of great surgical judgment both at operation and subsequently. At

the operation drainage is the essential thing; the operation must not stop short of it no matter where it leads one. Following the operation, with a sick patient, the desire to be doing something often leads to excesses of treatment that are undesirable. Even if all the symptoms persist following such an operation, nothing is to be gained by further disturbance of the wound. Dressings which are nearly always resorted to should therefore not be done.

I am not enthusiastic about intravenous antiseptics. Transfusion may certainly sometimes be of assistance and especially if blood can be obtained from a person who has recovered from sepsis similar to that from which the patient is suffering.

On the whole the best measures are such physical and physiologic rest as may be obtained and the treatment of other foci as they arise.

Case 4.—E. B. M. was examined on July 23, 1926, because of multiple metastases secondary to furuncle of the left buttock. The radiographs showed an involvement of the left scapula with a destructive proliferating process of the greater portion of the body. The right scapula showed a similar involvement not quite so extensive. In the upper end of the ulna, about one-half inch below the joint surface, there was a slight thinning of the density, with some disturbance in the bony trabeculations. In the lower diaphysis of the right radius there was a hollowed out defect in the contour of the bone about one and one-half cm. in length. The head, neck, and trochanteric regions of the right femur presented a moth-eaten appearance. There was also a definite proliferation in the lower one-third of the right femur extending to the epiphyseal line. The second right metatarsal bone presented a punched out defect in the joint. Because of a hemoglobin of 40 per cent and red cell count of 2,000,000 a transfusion was given before operative procedure. Following this a radical sequestrectomy was performed on each lesion allowing sufficient time to elapse between for necessary postoperative recovery. Each wound was packed and treated by the Orr method and not disturbed until fully healed. The convalescence was entirely uneventful and nine months later the patient was carrying on his normal activity. To date there has been no further metastasis.

Secondary bone and joint lesions (septic metastasis) are common in furunculosis. They are the result of late or inadequate drainage, of failure to protect the affected part against irritative motion, or of frequent disturbances of

the wound surface by dressings. In such primary lesions as the above I have obtained excellent results by adequate incision, swabbing out with pure carbolic acid and alcohol, packing with a sterile vaseline gauze pack, and finally the application of a thick cotton and muslin bandage collar that supports and partly immobilizes the head upon the shoulders. No dressing is to be done except for profuse discharge (which should not occur) until the patient is apparently well.

If, as in this case, septic metastasis has already occurred, each secondary lesion should be treated by drainage, vaseline pack, and cast exactly as a primary lesion. In this way only can the chronic suppurating contracted limbs, such as we often see in such cases, be regularly avoided.

In a case in which such a patient has already developed contracture deformities these should also be corrected at once or by easy stages as the osteomyelitic foci are healing. When deformities of this sort must be corrected in two or more stages, careful immobilization and in the improved position in plaster for from two to four weeks between manipulations is of great importance.

Case 5.—H. C., male, aged eight years, was examined because of swelling over the body of the left scapula. X-ray showed a sequestrating area in the anterior portion of the left scapula. The white blood count was 17,000 and the polymorphonuclear 89 per cent. Sequestrectomy removing the anterior table of the scapula was done, granulations were removed and the wound was treated by the Orr method. The packing was not removed for one month, at which time the wound was found to be clean and nearly healed. Daily dressings were applied for a period of two weeks, at which time the wound was entirely healed. Three months later the same patient was admitted to the hospital because of a metastasis in the upper one-third of the left humerus. A radical sequestrectomy was done and the Orr method again used, followed by a plaster arm and shoulder cast. The patient was returned to Arizona and reported by letter two months later that the cast and packing had just been removed and the wound was found to be clean and healed except for a small skin area. To date the patient's progress has been uneventful.

Dr. Ralph Soto-Hall, of San Francisco, reports the following four cases:

Case 1.—P. G., aged forty-three years, male, white. French Hospital.

Diagnosis.—Osteomyelitis of the right tibia.

History.—In 1920, patient suffered compound fracture of the right tibia, when he was kicked by a horse. About four months after the injury the wound healed and remained so until one year ago, when following pain in the leg, a sinus opened which has been discharging purulent material ever since.

Examination.—A well-developed man with a systolic murmur at the apex and aortic area.

Right leg: A draining sinus at the middle third.

Radiologic Examination.—Sinus pocket in the shaft of the tibia at the site of the old injury. There is considerable mottling around this area.

Wassermann.—Negative.

Operation.—January 26, 1928, wide drainage and incision of the affected bone. Wound was packed with vaseline strips and a plaster spica was applied. No rise in temperature postoperative. On February 21, 1928, the cast was removed, the wound was redressed and packed with vaseline strips. Considerable healing had taken place; extensive granulations. The plaster spica was re-applied. On March 26, 1928, the cast was removed, and the wound was fully healed. Heliotherapy to the leg.

April 17, 1926, the patient was discharged. Cured.

Case 2.—C. D., aged sixty years, single, an elevator man, had draining sinuses of the right leg. French Hospital.

History.—On April 23, 1926, patient fell four stories and sustained multiple fractures, among which were compounded comminuted fractures of the right tibia and fibula. The patient was operated upon some months after for the osteomyelitis, but the wound continued to drain, and he has had multiple sinuses to the present date.

Radiologic Examination.—Extensive osteomyelitis of the distal third of the tibia with several definite sequestra.

Operation.—April 13, under general anesthesia, wide drainage, and saucerization of the right tibia. Sequestrectomy. Vaseline strips and plaster spica were applied.

Postoperative Course.—Following day the temperature rose to 99½°, but has remained normal ever since.

It is about five weeks since the operation, and the cast has been left undisturbed.

Case 3.—P. V., male, single, thirty-six years of age. San Francisco City and County Hospital.

History.—Admitted to the hospital November 26, 1926.

Complaint.—Painful ulcerated right ankle of one and a half years duration.

Radiologic Examination.—Shows marked soft tissue swelling over the internal malleolus which is irregular and appears to be eroded. Considerable periosteal proliferation. Clinically the patient has tuberculosis of both lungs.

April 26, 1927, from inoculation of the lesion, the guinea pig test for tuberculosis was positive.

The ankle was treated with heliotherapy until February 22, when it was decided to operate to clean up the secondary infection.

Operation.—March 14, 1928, spinal anesthesia. Excision of the lesion. Curettage and drainage of the tibia. The wound was packed with vaseline strips, and a plaster spica was applied. April 10, 1928, the cast was removed, and the wound was healing well. New vaseline strips were inserted and a plaster spica was applied.

Résumé of the Case.—A tuberculosis of the right tibia with extensive secondary infection, which had resisted one and a half years' conservative treatment. The patient's maximum postoperative temperature was 100°. On the ninth day it returned to normal and has remained so since. The wound is healing rapidly, but the case is not yet terminated.

CASE 4.—R. P., male, married, twenty-seven years old.

Complaint.—Draining sinus of the left femur.

History.—In 1918, during the world war, this patient suffered a fracture of the left femur, which was subsequently infected by a surgical procedure. There has been a draining sinus at intervals since the accident, and the patient has undergone several surgical attempts at drainage by various surgeons without success. This patient has a draining sinus on the lateral aspect of the left thigh.

Radiologic Examination.—Shows extensive sclerosing osteomyelitis of the lower end of the femur.

Operation.—February 11, 1928, wide drainage of the osteomyelitis by lateral incision. The wound was packed with vaseline strips and a long plaster spica was applied. On February 28, the cast was changed and the wound was repacked with vaseline strips. Granulations grew rapidly. On March 17 plaster immobilization was discontinued. On April 1, the wound was completely healed and the patient was able to walk. There was no rise in temperature postoperatively.

It has been a matter of great interest that some of the oldest and most chronic cases have healed rapidly and completely when treated in this manner. The two factors of great importance are undoubtedly an adequate surgical procedure and the avoidance of repeated infections by frequent dressings. Any one who has undertaken a fairly extensive clinical experience with this method, however, will soon be persuaded that efficient immobilization after operation is a necessary factor.

I have been approached many times on the proposition that one item or the other in my plan of treatment is the only one that is really essential, i.e., the operation, the vaseline pack, the infrequent dressing, the cast, et cetera.

As experience accumulates, however, it becomes increasingly evident that the best consistent results are to be obtained only by a compliance with all these items which are based upon sound surgical principles.

Dr. Philip Kreuscher, of Chicago, became interested in my method of treating osteomyelitis and compound fractures in 1926. Later, he presented a clinic before the Chicago Surgical Society in which a number of striking cases were shown. All of these were healed or healing in a most satisfactory manner. Upon Dr. Kreuscher's invitation, Dr. Gaenslen, of Milwaukee, whose experience with the method is quoted elsewhere, Dr. Steindler, of Iowa City, and I were present and participated in the discussion.

Dr. Kreuscher reports in a recent personal communication that he has now treated eighty-four of these patients by my method. In recent cases he has entirely abandoned the use of sutures and drainage tubes which he did use for a time, and has become more strict in the use of casts until healing is complete or at least very well established.

Dr. Kreuscher has kindly sent reports of several cases from which the three following are selected for comment:

CASE 1.—Mr. J. D., admitted February 19, 1926; discharged May 24, 1926.

Diagnosis.—Chronic osteomyelitis of femur.

Present Complaint.—Pain in right hip and thigh; discharge from sinuses in right hip and thigh.

Patient states that the initial causative factor of his present condition was gunshot wound sustained about fourteen years ago. At that time some of the pelvic bone was resected. He has experienced trouble with the site of the injury at different times since and one year ago last September, he was seized with pain, fever, and chills. He was operated upon twice after that, but the discharging sinuses have persisted. Last Saturday, after he got up from bed and had gone downstairs, he was seized with a sudden pain in the same region and had an extremely high fever and chill. He has used canes and crutches since his last operation.

Physical Examination, Essential Pathology.—Reveals a somewhat emaciated white male about twenty-five years of age, who is not acutely ill but complains of considerable pain at the site of lesions on hip and thigh. There are three discharging sinuses about the hip joint, one more dorsally and the other two anteriorly. On the anterior surface of the proximal third of the thigh there is an ulcerated area about the size of a silver dollar. The member is about one inch shorter than the left. (Fig. 46.)

Fig. 46.—Case No. 1. (Dr. Kreuscher.) The acute osteomyelitic area is clearly shown just below the trochanters. Such areas are always due to failure to relieve an active septic area in bone while it is in the acute stage.

Blood.—Hemoglobin 65 per cent; red blood cells 3,480,000; white blood cells 12,800.

Operation.—The skin, fascia, and muscles on the inner side of the thigh were opened and the bone exposed. The osteomyelitic focus was curetted, and three drains were inserted. The skin edges were freshened, and the muscle fascia and skin were closed with three silkworm-gut sutures. Vaseline pack was inserted before closure.

Note.—A verbal report from the patient just received in May, 1928, states that the wounds are entirely healed. (Fig. 47.)

The above illustrates a situation that must occasionally be met in dealing with compound fractures. Foreign bodies and obviously infected areas must be treated sometimes with the idea of healing them in. This, of course, is the method employed in all primary sutures and in all secondary closures. It is my opinion that such closure is always a compromise, though it may and does frequently succeed.

In this case Dr. Kreuscher has succeeded doubly. He has not only healed in his foreign bodies but has also accomplished in part a secondary closure. This was done with the suture over a vaseline pack. A considerable number of other correspondents have reported similar experiences. I advise, however, that in such cases a wide open pack without tubes or sutures should always be employed.

Recourse to this plan should be had in those cases, which we so often see, of infection following a plating or bone graft operation for fracture. I have on numerous occasions resorted to wide open packing of such areas without even a new operation and have seen the fractures unite before the plates or grafts had to be removed. To accomplish this, it is important to maintain the injured part carefully in the original cast or splint or to correct the position if necessary. One should employ a new cast and even additional traction to bring the fragments into proper relationship and to immobilize during the whole period of healing, if that has not already been provided for.

Case 2.—S. H., admitted September 13, 1927; discharged December 6, 1927. *Diagnosis.*—Osteomyelitis of left femur.

Fig. 47.—Case No. 1. (Dr. Kreuscher.) Shows the excellent end-result obtained in this case.

Present Complaint.—Patient was struck by a wagon July 18, brought to Cook County Hospital the same day and operated upon by Dr. Koch. Diagnosis was osteomyelitis and patient was confined for three weeks. At present time he is unable to walk and fully extend leg. He has very much pain; a sinus-like opening still persists.

Physical Examination, Essential Pathology.—Extremities: Right femur at the inner supracondylar ridge shows sinus-like perforation from previous operation.

Blood.—Hemoglobin 70 per cent; red blood cells 3,800,000; white cells 15,450. Differential: Polymorphonuclear neutrophils 69, lymphocytes 27, large mononuclears 3, eosinophils 1.

Operation.—Incision was made over the right lower femur exposing sinus-like tract which was curetted. Invasion through epiphysis into joint was shown. Opening was packed with vaseline dressing and laid open; no sutures were used.

In the x-ray illustrations of the above case (Figs. 48 and 49) we have a splendid demonstration of the bone condition that remains after treatment by my method. This patient, it will be observed, was operated upon three weeks after his injury for an osteomyelitis that was still in the acute stage. A previous operation had succeeded as such operations commonly do, in that it gave the patient only a sinus drainage. The more radical operation preformed at the end of three weeks is shown by the condition of the bone in the x-ray after healing. This is the kind of drainage that is necessary, especially in osteomyelitis that is very active in the vicinity of the knee joint. Wide packing, with plaster cast fixation leads to early and complete healing, as it will do in practically all of these cases. Also this is a lesion somewhat more serious than the average with involvement of a neighboring joint. It has remained healed for about one year.

Case 3.—Mrs. M. W., admitted November 2, 1927; discharged December 18, 1927.

Diagnosis.—Paget's periostitis of left tibia.

Present Complaint.—Pain and redness over left tibia. Patient states that two years ago she first noticed a pain in her leg. This was followed by the forming of a red spot that gradually became larger and more swollen. This was incised and drained for about six weeks. This has happened four times since and the same procedure was followed in each case. Pain comes on mostly at night and seldom in daytime.

Physical Examination, Essential Pathology.—Negative except for a red swollen area about three inches in diameter on anterior aspect of tibia in lower one-third.

X-ray.—November 4, 1927. Left leg: The roentgenograms taken in two views, anteroposterior and lateral, show considerable periostitis involving three

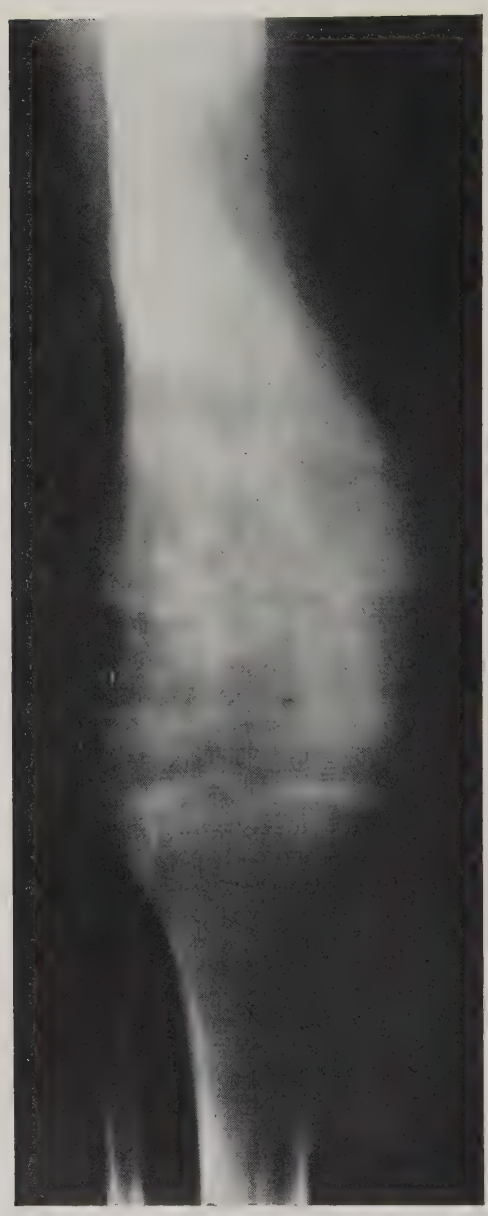

Fig. 48.

Figs. 48 and 49.—The ideal manner in which a properly "saucerized" osteomyelitic cavity will heal from the bottom outward in these cases. By this method a minimum (if any) of infection is healed over into the wound.

Fig. 49.

inches of the tibia at the junction of the middle and lower thirds. These findings are indicative of a chronic infection.

Blood.—Hemoglobin 85 per cent; red blood cells 5,150,000; white blood cells 8,600. Differential: polymorphonuclear neutrophils 56, lymphocytes 42, large mononuclears 2.

Operation.—Incision over left tibia exposing bone for six inches. The periosteum was thickened for one-fourth of an inch and the bone was hard and thickened. The medulla was found to contain a pus sac about four inches above the joint. The bone was scraped, leaving a cave-like opening with no obstruction from soft parts. Three vaseline packs were placed in the cavity; no sutures.

Here we have a patient with a chronic osteomyelitis of somewhat uncertain etiology; the infection, at any rate, was of the variety commonly referred to as low grade. It had become chronic with fairly acute recurrences on at least four occasions. Drainage by incision had afforded relief but not a cure. Undoubtedly the infection had become somewhat mixed. The x-ray illustration taken some months after healing suggests a chronic osteomyelitis of the ordinary type. (Fig. 50.) The wide drainage of the entire tibia followed by packing resulted in a prompt and apparently satisfactory healing. The ultimate career of this patient, as of many others described here, will be a good test of the permanency of the results to be obtained by this method.

Not a great deal has been said about the infrequency of recurrence following the employment of my method. It is a fact, however, that of some hundreds of cases of acute and chronic osteomyelitis that have now come under my observation during the past five years, only two or three recurrences have been observed. It is my very distinct impression, as it is of others with whom I have talked of this method, that the results obtained in this way are very much more permanent than those previously obtained.

One of my most enthusiastic audiences has been at Seattle, Washington. In 1926, the method was demonstrated at Lincoln to Dr. Roger Anderson, of Seattle, and immediately adopted by him. Upon Dr. Anderson's invitation I went to Seattle in June, 1927, and operated upon

Fig. 50.—Case No. 3. (Dr. Kreuscher.) This illustrates an ideal "saucerization" of a tibia and excellent healing. In the acute cases less of a bone opening may be required for drainage, while in the severe cases of chronic type there may be areas of disease at or near the epiphyses that require more thorough opening.

several patients. The matter was also discussed very briefly before the County Medical Society. In February, 1928, it was my privilege to visit Seattle again under the auspices of the Seattle Orthopedic Society. Upon this occasion dry clinics were held on Friday morning and Friday afternoon and an operative clinic on Saturday morning, with an illustrated lecture on Saturday evening. At all of these occasions osteomyelitis cases and compound fractures were presented and discussed. Dr. Anderson and others showed excellent results obtained in the manner that I have advocated and described. Two of the patients upon whom I operated in June preceding, nicely healed, were shown.

At the Saturday morning operative clinic Dr. Eikenbary, of Seattle, presented one case, a boy with osteomyelitis of the tibia, which had been operated upon one month previously. The wound had been packed widely open with a vaseline pack and a below-knee cast had been put on. Also the boy had been allowed to be up and around. Dr. Eikenbary believes that less immobilization than I advocate is sufficient in many of these cases.

Dr. Eikenbary consented to bring the boy before the clinic and remove the cast and do the dressing. Certainly this case was a striking demonstration of the fact that patients will do well under less than ideal conditions. The boy was very active, and had been about during the entire time since operation. The cast was badly soiled. Since the operation, however, there were no complications as to pain, deformity, swelling, or anything of that sort.

Upon removal of the cast and dressing before the clinic the wound was found to be almost perfectly clean; the skin edges were already healed over the edges of the bone cavity, and the entire wound and limb were found in excellent condition.

At the same clinic Dr. Wyckoff presented two cases. Dr. Wyckoff has kindly sent case reports and illustrations for presentation at this time.

My dear Dr. Orr:

I am enclosing summaries of two cases of osteomyelitis with x-ray prints, which I hope will be of some use to you.

The case with the drop ankle has not had a recent x-ray—one would probably show considerable improvement.

On my prize case, unfortunately, we have misplaced the x-ray pictures and cannot locate them at this time.

. . . . . .

Very sincerely yours,
(Signed)
H. J. Wyckoff, M.D.

Case 1.—Mary C., six years old.

Family History.—Negative.

Previous History.—Full term; normal birth; healthy child.

Present Trouble.—In August, 1926, child turned on ankle while playing. Scarlet fever one week later. Six weeks after injury ankle was swollen considerably and became very tender. Skin broke down with exudation of pus. Lanced several times.

Examination.—Several ulcerated and angry looking areas of skin over internal and external malleolus and dorsum of left ankle. There is an exudation of pus from two of these areas. Edema extending from ankle half way up the thigh. Tender to touch.

X-ray.—Numerous areas of rarefaction involving entire lower third of tibia with apparently some involvement of upper end of astragalus. Fibula apparently not involved excepting possibly some periosteal thickening extending along medial side—lower end.

Dec. 10, 1926: *Operation.*—Five inch incision over lower end of tibia. Necrosed bone was removed as well as several sequestra. It was necessary to remove the entire tibia except for a small posterior bridge over an area of about three inches. Wound packed with vaseline strips. Cast applied from loin to foot.

Jan. 17, 1927: Wound still draining. Very little local pain.

Feb. 25, 1927: Old cast removed—posterior mould applied.

May 4, 1927: Sinuses on leg almost completely closed. Irrigated daily with Dakin's solution. (Child has had whooping cough.)

June 6, 1927: Spicule of bone removed from lateral aspect of ankle.

July 8, 1927: Sinus over the foot is healed; two sinuses still draining above malleolus. Looking very good.

July 23, 1927: All sinuses healed. Adherent scars; very little motion in ankle joint but good motion in tarsal joints. Foot in good position. Should give good functional result. Scars may be released at a later date.

Dec. 6, 1926: *X-ray.*—Showed considerable mottling with necrosis involving the lower portion of the tibia, both the diaphysis and epiphysis, with some necrosis involving the neck of the astragalus. (Fig. 51.)

Mar. 12, 1927: *X-ray.*—Showed considerable loss of bone substance from the anterior portion of the lower third of the tibia. There were no sequestra present and the process showed considerable healing as compared with the previous x-rays. (Fig. 52.)

In this case Dr. Wyckoff describes a condition and result which are quite typical of the chronic form of osteo-

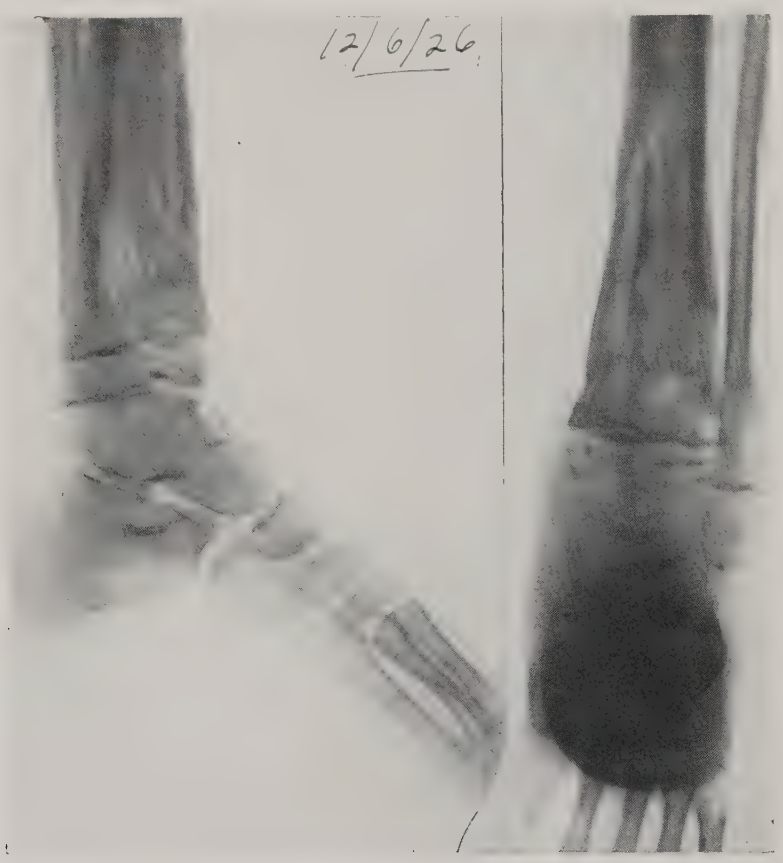

Fig. 51.—(For description, see text.)

myelitis in which I first employed the no dressing method. In these cases, while the results are less brilliant than in certain other kinds, they are no less satisfactory.

The kind of case described here is the one in which, in

times gone by, and even at the present time, we have been accustomed to have frequent operations and frequent recurrence. This has been due to the fact that upon each occasion the minimum of operating was done and the parts

Fig. 52.—(For description, see text.)

were allowed to heal with the inclusion of septic areas or even areas of dead bone which had not been removed. It is not uncommon to see patients who have been having such repetitions of surgical operations and sinus formation extending over periods of ten, twenty, or thirty years. I find that fairly radical operation followed by the kind of postoperative care that I advocate gives a kind of sound healing that we have not been able to obtain regularly heretofore.

Another point that needs reassertion is that by the method described in this report plastic flaps are not required in order to secure healing of large bone and soft part wounds. In all cases in which I have employed the vaseline pack and a long period of immobilization these wide spaces over the tibia have become covered with skin in a comparatively short time and have remained healed. There is, to be sure, a considerable part, sometimes, in which the bone is covered only with skin; but it has been found that these are less likely to flare up with new inflammatory conditions than those cases in which septic areas have been covered with flaps of one kind or another before recovery from infection is complete.

The x-ray of this case shows a very extensive disease which has been well drained. It would be my plan to remove the covering of the infected area about an inch or an inch and a half higher than was actually done in this case. However, adequate drainage is the essential thing, and that has been done very well.

Case 2.—L., five years old.

Family History.—Negative.

Previous History.—Full term, normal birth, breast fed. Healthy child.

Present Trouble.—History indefinite. Complaint of pain in left ankle about six months previously, with abscess formation. More recently trouble has developed about the right wrist.

July 1, 1927: X-ray shows marked destruction involving the entire diaphysis of the radius with marked roughening and sequestrum on the left.

Aug. 5, 1927: Radical incision of left ulna. An incision was made to one side of a draining sinus leading to necrotic bone of the left ulna. This incision was almost the entire length of the forearm. Necrotic bone was ex-

posed by further dissection. By means of rongeur forceps the bone was guttered. Sequestrum 3½ inches long was found in the middle portion of the bone. The bone was curetted and all overhanging ledges were removed until it was thought that all necrotic bone was removed. Sinus was likewise curetted and the incision packed with vaseline gauze. Three silkworm sutures

Fig. 53.—(For description, see text.)

were used to bring the edges within one-half inch of each other. Cast, including the hand and running up to the armpit, was applied.

Sept. 3, 1927: Wound dressed, moderate amount of discharge. Wound looked good and granulation tissue had begun to fill cavity.

Sept. 21, 1927: One small draining sinus remains. Two small sequestra have been extracted during the past few days.

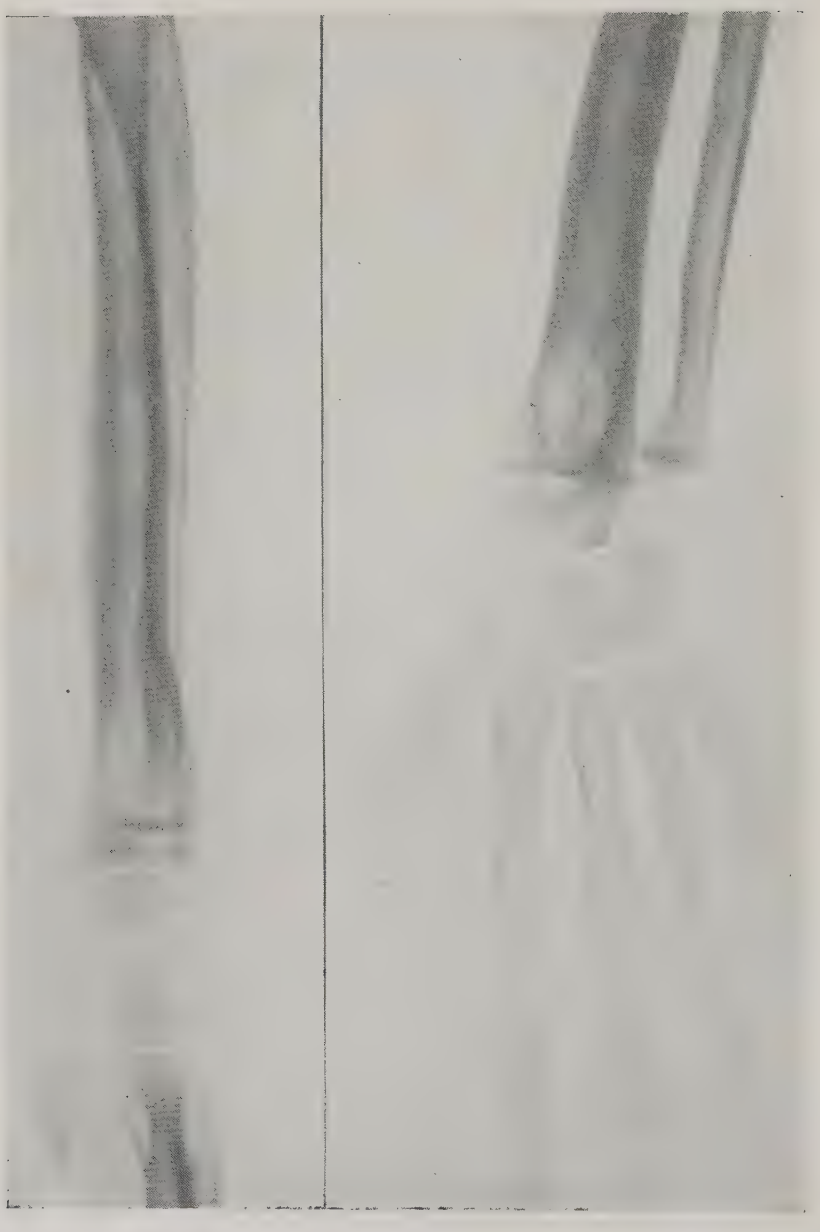

Fig. 54.—(For description, see text.)

Sept. 26, 1927: X-ray of ulna showed no bowing, filling in of new bone with increased density in the center of the upper third with rather less of bone substance at the junction of the middle and lower thirds. (Fig. 53.)

Oct. 28, 1927: Wound apparently healed.

Nov. 10, 1927: X-ray showed considerable return of bone detail with slight irregularity of the lower one-third—some decrease in bone density. Left radius—and some thickening of the middle third of the shaft. (Fig. 54.)

In this case the x-ray illustrations furnish their own comments. Adequate drainage of a very severe osteomyelitis has been followed by prompt and complete recovery. In this case a radical incision in August was followed by apparently sound healing in about ten weeks. The first dressing was done in about one month, the second dressing in about seven weeks. Recovery, not only of the patient but of the diseased bone, has been so rapid and so complete that it furnishes a striking illustration of the fact that irrigations, dressings, and such treatment are certainly uncalled for in this class of cases.

At a meeting of the section of orthopedic surgery of the New York Academy of Medicine on November 18, 1927, Dr. Samuel Kleinberg, of New York, presented four case reports as illustrative of results obtained by the Orr method which was under discussion.[1] The reports are the following:

"Case 1.—Rose B., eight years old, has had osteomyelitis of the right big toe for about a year. She had an operation soon after the onset of the osteomyelitis, but the wound is not healed and she has had a persistent sinus, swelling of the toe, and disability.

"Our examination showed extensive involvement of the proximal phalanx of the right big toe. On April 12, 1927, an operation was performed. All of the diseased tissue was removed, the wound was packed with vaseline gauze, and a splint was applied. The splint was not removed for a number of weeks at which time it was found that the cavity was filled with granulation tissue and there was no further active infection. The wound healed rapidly and has remained healed.

"Roentgenograms show satisfactory regeneration of bone."

[1]Kleinberg, S.: Four Cases of Osteomyelitis, Am. J. Surg. 4: 475, May, 1928.

Orr, H. Winnett: Listerism, Properly and Improperly Applied in the Treatment of Infections of Bones and Joints, Am. J. Surg. 4: 465, May, 1928.

Severe and extensive infections about the hand and foot are very common. These are usually treated by superficial incision, fomentations, and the rest. I have found that many of these cases of supposed cellulitis, tendon sheath infections, and similar difficulties are really osteomyelitis of the phalanges, metatarsals, and metacarpals. Deep drainage—into the bone if necessary—is indicated in these cases. Subsequent mixed infection of these cases, especially by poultices and so-called antiseptic dressings, has been the rule. The extensive sloughing and spread of infection so commonly seen must be attributed, I feel, almost entirely to these methods of dressing and disturbance. The above case shows very well what I have seen in many others, that about the foot free drainage with thorough dressing and splint protection against irritative motion and further infection is the ideal way to manage such a case.

"Case 2.—Milton G., three years old, was brought to the Hospital for Ruptured and Crippled because of swelling of the right ankle and leg. His trouble started three weeks previously, since which time he had pain in the right ankle; swelling and tenderness of the lower part of the leg, and persistent fever.

"Roentgenograms showed extensive destruction of the lower extremity of the tibia, the disease invading the ankle joint. An operation was performed on March 21, 1927. The abscessed cavity was exposed, the diseased bone was removed, the cavity was packed with vaseline gauze and a plaster of Paris bandage was applied from the toes to the knee. The bandage was removed three weeks later when it was found that the cavity was filled with granulation tissue which looked healthy. The surface healed rapidly and has remained healed since then.

"A recent examination showed that the boy walks without a limp, the wound remains healed, and he has no symptoms referable to the affected member.

"Case 3.—William S., fifty-two years old, was seen first on April 29, 1927. He had osteomyelitis of the lower half of the left leg. One and a half years ago he sustained a compound fracture of the left leg. Osteomyelitis developed. He has had several operations but they have been unsuccessful. The symptoms have persisted and several sinuses have remained unhealed.

On May 3, 1927, an operation was performed. All of the diseased tissue was removed. The wound was packed with vaseline gauze and left widely open. A plaster of Paris bandage was applied. The first dressing was done three weeks after the operation, and subsequent dressings have been done at

very infrequent intervals. The wound has been healed completely since August, 1927, since which time the patient has had no symptoms and walks about liberally.

"CASE 4.—Herman F., thirty-two years old, had an osteomyelitis of the right sacroiliac area four years ago. He was operated upon, the wound healed after innumerable dressings, but he has had several relapses since.

"On May 20, 1927, an operation was performed. A large wound was made. The diseased tissue was thoroughly curetted and removed. The wound was packed with vaseline gauze, and a plaster of Paris spica bandage was applied. The original dressing was left on for four weeks. Since then he has had very few dressings. The wound was healed completely by October 1, 1927, and he has had no symptoms referable to his back since then."

Dr. Myron O. Henry has made a very careful study of a series of cases treated according to my technic. In a paper read before the Eau Claire and Associated Counties Medical Association on March 26, 1928, and later published in the *Journal-Lancet*, Dr. Henry summarizes the important ideas involved in the method, and outlines the steps in its procedure.[2] He then goes on to say:

A great advantage of the method lies in the comfort it gives the patient. One has only to think of the child with osteomyelitis and to remember the screams which heralded the approach of the daily dressing when treated by earlier methods. Sedatives are rarely needed after a properly applied Orr dressing. Pain in osteomyelitis is due to insufficient drainage, or inadequate immobilization. If the Orr treatment is to be satisfactory, both of these factors must be given close attention.

The operation which precedes the Orr dressing must be a thorough one. The incisions must be long enough to allow a complete cleaning out of the diseased area, together with removal of sequestra. The bone edges must be carefully removed and the bone cavities "saucerized" when it is at all possible. Overhanging edges must be removed and all pus-pockets evacuated. Inadequate immobilization interferes with free drainage, and it also prevents absolute rest, an important principle in the cure of nearly all diseases. Rest in osteomyelitis means not only muscular relaxation and fixation in correct anatomic postures, but it also means rest from irritating chemicals, bothersome dressings, and secondary infections.

The Orr method fosters localization of the inflammatory process, and thereby shortens its duration.

An advantage in this treatment lies in the ease with which the surgeon can handle the cases. The dressings are so infrequent that the surgeon need not turn them over to his assistant or nurse, but can, and should, give them his personal attention.

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[2]Henry, Myron O.: The Orr Method in Treatment of Chronic Osteomyelitis, Journal-Lancet. **48**: 240, June, 1928.

The remote advantages of the method are also significant. Rest in the correct anatomic posture prevents muscle spasm, and lowers the permanent disability so often seen in those cases, such as deformity, contracture, and ankylosis.

We have been using this method during the past two years with gratifying results. Some fifty cases have been treated during this period, and in this series there have been no deaths, and no second operation has been necessary, nor have sequestrae presented themselves for later removal. We believe that the method is a good one and that it represents a tremendous step forward in the treatment of chronic osteomyelitis. The method, however, is not foolproof. The user of this method must have, first of all, a thorough understanding of Orr's idea. The details of the procedure must be given close attention and carried out minutely in every respect.

. . . . . .

It may be further said that, while we believe the Orr method is a genuine advance in the treatment of chronic osteomyelitis, the other factors of the care should not be neglected. The value of fresh air, sunlight, good food, and careful nursing are not to be forgotten in the application of this, or any other, method in the treatment of chronic osteomyelitis.

Some of the consultations coming to me by mail have afforded an excellent opportunity to illustrate various points involved in the method under consideration. Such patients have not been seen by me, but suggestions made regarding treatment have been made strictly on those principles that should enter into the solution of every similar surgical problem. The following case makes a rather long story, but it is introduced because it is one of the most interesting.

On January 19, 1928, Dr. R. A. Bowdle, of East Ely, Nevada, writing to Dr. James T. Watkins, of San Francisco, described the following case which was sent to Dr. Watkins at that time.

On August 6, 1927, Fred S. was brought to this hospital with an acute osteomyelitis of the lower end of the right femur. The history was very typical: trauma, high elevation of temperature, high leucocyte count, pain, and swelling in the right knee. Under ether anesthesia that same day, I opened up the lower end of the femur, established free drainage with six drill holes and through and through drainage in the soft tissues with rubber tubing. The leg was put at rest in a splint. At this same time there was a great deal of infection in the soft tissues and I provided ample drainage for the same. There had been no denuding or breaking through of the periosteum. From the history the process had probably been of two or three days dura-

tion. The subsequent course of his disease was quite satisfactory. I maintained drainage until the wounds were clean and had stopped draining and his temperature, pulse, and white count had returned to normal. He was discharged from the hospital on September 30, 1927.

I am sending you the x-ray films taken at the time of his admission and on the day of his discharge. I have seen Fred several times since leaving the hospital and there has been nothing to indicate any trouble in the bone. There has been no tenderness, no pain on usage, no soreness on heavy percussion; the knee had practically returned to normal. He had gained thirty pounds in weight since leaving the hospital, and his mother tells me that he has eaten better than he ever has previously. He has been attending school and to all appearances was entirely well. He even took an automobile trip to Los Angeles during the holidays. I have not seen Fred for a month or more up to the present time.

Last night, January 18, 1928, he was brought to the hospital with a diagnosis of a fracture of the right femur. I saw him shortly before midnight. He gave a history of having slipped and then being unable to use his right leg; the x-ray film taken last night tells the story. This morning we took two additional films before he was in plaster. You will note that the fragments have slipped laterally slightly. We did not take any x-rays after the cast was applied. I have advised these people to put their boy in your hands.

When I looked at the film taken last night I was quite startled and entirely unprepared to account for his present condition. To all intents and purposes the boy has been as well as ever for the past two or three months. There has been nothing to in any way indicate that there was any trouble in the bone. He has been attending school, has gained thirty pounds since leaving the hospital and was apparently entirely well. By the way, I have not done a Wassermann. I presume that there were some bugs which were lying dormant in the bone and have quietly done their work. But why there should have been no manifestations of trouble with as extensive process as is apparently present now is more than I am able to understand. You would think that there would be some indication of the progress of disease.

Following Dr. Watkins' examination at San Francisco, he wrote to me regarding this case as follows:

My dear Orr:

I was reading last night Gaenslen's enthusiastic report of his results with your method of treating osteomyelitis and this morning the boy whose history and x-rays I am sending you appeared at the St. Francis Hospital.

I have a notion that the fracture will heal without surgical intervention. Mind you it is only a notion. If you know better or think differently please advise me.

This boy, today, has no sinuses, his temperature has been subnormal for three days. His Wassermann and Noguchi, etc., are negative. His blood count is: erythrocytes 4,640,000; hemoglobin 35 per cent, white cells per cubic mm.

21,000; polys 76 per cent, large lymphocytes 20 per cent; transitionals 3 per cent; basophiles, 1. His urinary specific gravity is 1.034. Everything else is negative.

Since the last of September he has put on thirty pounds of weight. I have an idea that as he attempted to replace old bone with new the latter absorbed more rapidly than the new was laid down and that at the moment of minimum tensile resistance he broke his thigh.

In the absence of symptoms and on the basis of fracture and x-ray alone, would you operate? My personal inclination, based upon a very moderate clinical experience, would be to let the whole thing alone unless he developed some other untoward symptom.

James T. Watkins.

P. S. This was dictated before I got the blood count which as indicated above is 21,000. I have always uncovered femurs by separating the fibers of the external vastus—an oblique incision. In a recent *British Journal of Surgery* an Irish surgeon described an anterior external incision. What do you suggest? Apparently this whole femur must be opened as far anyhow as the lesser trochanter level.

J. T. W.

My reply to this is indicated in the two telegrams following, which were sent the same day that the x-ray plates were received and examined:

To Dr. Watkins:

Advise drainage of lower one-half of femur through lateral incision. Double spica cast. Please see Dr. Ralph Soto-Hall who has just been here for details of technic.

To Dr. Ralph Soto-Hall,
San Francisco.

Dr. Watkins has asked me about my method of treatment for a case of osteomyelitis. He was in doubt as to how to go about it and I have asked him to get in touch with you for details of technic.

On February 4, Dr. Bowdle, as a result of his interest in this case, wrote to me as follows:

My dear Doctor:

I believe that you have recently heard from Dr. James T. Watkins, of San Francisco, relative to an osteomyelitis of the right femur in Fred. I referred this case to him, sending the brief history of his acute illness, x-ray films, and subsequent progress. I am in hopes that Dr. Watkins forwarded all of these to you when he asked for your opinion and advice.

We have operated upon a number of the acute osteomyelitis cases in children but this one in some way has been a puzzle to me. I operated upon Fred the morning that I saw him and established drainage by drill holes in the lower end of the femur into the medullary canal. His subsequent prog-

ress was apparently satisfactory. His temperature, pulse, and leucocyte count dropped rapidly to normal. The leg was immobilized for two months. At the time of his discharge from the hospital he was in good condition. There had been no drainage for at least two weeks previous. An x-ray taken two months after the acute infection did not show any apparent bone damage. The boy walked upon crutches and after Thanksgiving returned to school. I saw him occasionally and there was no indication of anything wrong. He gained thirty pounds in weight and his parents remarked the fact that he was in better condition than he had been for years. Fred took an auto trip to Los Angeles at Christmas time. The first intimation that we had of trouble was when he was brought to the hospital with a pathologic fracture of the middle third. The femur was riddled.

Why should this process go on silently without clinical symptoms and with the patient gaining in general health? He had put on thirty pounds. I know that x-rays that are negative during the acute process are part of the diagnosis but would you think that those taken over two months later would have showed something?

I am most interested in this case, and if you have had sufficient data concerning it, would greatly appreciate your opinion and criticism of it. Perhaps the leg was not immobilized for a sufficient length of time or the primary drainage was inadequate.

(Signed)
R. A. Bowdle.

The following is my reply to Dr. Bowdle's letter:

Feb. 7, 1928.

Dear Doctor:

Please accept my thanks for your letter of February 4th. I am very glad to have this letter from one who has given this subject as much consideration as you evidently have. I think that both the assumptions you express in your last paragraph are correct. In my opinion your primary drainage was sufficient to stop a severe case, still the interior of the femur was not sufficiently drained but that a gradual extension of the infection took place.

I think immobilization is of the greatest importance in arresting and controlling these infections. What happened after your primary drainage was that the patient was able to combat the infection up to a certain point, beyond that, however, there was a gradual spread of what we are pleased to call a low grade infection but which was being dealt with almost successfully by his natural powers of resistance. He was able to prevent the spread of the acute condition but developed a gradual extension of the infection into the region of the femur with the damage one sees now in the x-ray.

The patient needed more drainage in the first place and a longer period of protection in casts or splints in order to prevent what happened. We see the same sort of thing that this boy presents on a small scale in those cases in which there is an acute infection for a few days and later we find a

small cavity in the bone and which we call a Brodies abscess. In this case the thing did not localize so sharply and more damage resulted by a process otherwise almost identical with that which takes place in a Brodies abscess.

I shall be in Seattle, February 23d to the 25th. If you should by any chance have an opportunity to come up to the meeting I shall be glad to talk this and similar cases over with you. I think this is a very important work and has a bearing on a large number of bone infections, fractures, etc. I appreciate your interest and shall be glad to cooperate with you at any time in helping to work out any of these problems.

(Signed)
H. Winnett Orr.

On February 17, Dr. Watkins sent the following report:

Except for the fact that Soto-Hall had written you in detail of our attempt at performing your operation I should have written you long ago.

It is now more than two weeks since we operated. Blood count and temperature are normal, patient eats, sleeps and feels well; to date there is no odor to speak of.

Soto-Hall seems to think that my trick of stitching periosteum to skin and using surface gauze wrung out on two per cent carbolic may be in some way responsible for this absence of smell.

Soto-Hall wants me to dress it again in two weeks hence. That will make a month elapse from the time of operation.

I trust that is right. If I save this limb you may expect some boosting for your method that will count. I did not leave more than a third of the shaft below the fracture. It separated spontaneously.

. . . . . .

(Signed)
James T. Watkins.

May 30, 1928.

Dear Dr. Orr:

. . . . . .

The boy in question is recovering slowly. I do not like the Dublin man's incision. There will be some slight shortening and it will take a long time to fill in the great space left by the loss of the outer half of the shaft of the lower fragment.

(Signed)
James T. Watkins.

There are several points of considerable importance in connection with this case. They may be summarized as follows, although the entire case is well worth rereading and careful study: In the first place, drainage by drill holes at the time of the original attack was insufficient. If the

infection had assumed what is commonly called a more virulent form, the patient might have lost his life. With just sufficient drainage to enable the patient to gain a certain mastery over the infection, however, he went on to an apparent recovery, but actually with a very gradual spread of the infection and necrosis which became apparent only after a long time and upon fracturing the femur. Thereupon one examiner at least made a diagnosis of a malignant growth in this femur. This is a common occurrence. Fortunately the white cell count gave a clear indication for drainage. In a case of this kind my method of placing the patient on a table with good traction and careful immobilization before beginning the operation is a point of great importance. This applies in all inflammatory cases as well as in fractures where manipulation at the time of operation or immediately following should be carefully avoided. The indication at operation is for the limb to be kept carefully immobilized just as it is during the period of healing afterward.

Finally, as previously pointed out, it is only necessary to drain these patients well and immobilize them carefully in correct position to secure a healing of a fracture as well as a recovery from the osteomyelitis. Bone production takes place in the presence of infection, if the infection is controlled either by drainage or by the natural resistance of the patient. Good results are therefore to be expected regularly if my method is employed.

Dr. Watkins' inquiry regarding the matter of odor in this case also calls for comment. In some cases of chronic osteomyelitis in which mixed infection (colon bacillus, B. pyocyaneus, and the like) already exists or in which such infection takes place at operation, or at postoperative dressing, odor is to be expected, and it is sometimes difficult to prevent or relieve. In Dr. Watkins' case no such mixed infection was present when he operated, none was introduced, and no dressings were done. This sums up the whole matter not only for odor but for other kinds of infection as well.

On a number of occasions letters of inquiry have been received regarding the kind of vaseline to be employed and the manner of its use. The following inquiry is typical and may perhaps answer the questions of many who are interested.

Dear Doctor Orr:

. . . . . .

May we ask you whether you are using any special brand of vaseline for your gauze drains and skin protection? Our own vaseline seems to have a very low melting point, for it liquefies at body temperature and is washed out of the gauze with the wound discharge, with the result that the gauze has caked and in several cases has blocked drainage. There have been a number of other cases since then and the results have been uniformly splendid.

Respectfully,
J. E. Milgram.

J. E. Milgram, M.D.,
Iowa City, Iowa.

Dear Doctor:

Your suggestion about the vaseline is quite correct. We have been using a much heavier vaseline here and have no difficulty about the involvement of the gauze in the bone. I think if you will use the heavier vaseline or petrolatum, you will have no further difficulty.

. . . . . .

Very truly,
H. Winnett Orr.

An excellent method of preparing the vaseline is to fill jars of various sizes with sterile gauze and to pour melted vaseline over them. These are then sterilized in a pressure sterilizer, after which the covers of the jars are screwed tight. This gives a sterile gauze well permeated with sterile vaseline. When it is used, the vaseline does not adhere to the bone, and the entire mass is pushed out in the healing.

Some time after the letter reproduced above was sent to Dr. Milgram, the following reply was received. Because of the additional data it contains it is included:

May 23, 1928.

Dear Dr. Orr:

Since our adoption of a heavier grade of vaseline for impregnating wound packings, we have had no further trouble with obtaining free drain-

age. In one case in which overhanging bone edges had been inadvertently left at operation, the gauze was not spontaneously extruded. Since attention has been paid to this detail, the difficulty has not recurred.

You may be interested to know that the treatment has been, and is being carried out in principle and detail at Dr. Steindler's clinic in all cases of acute osteomyelitis, chronic osteomyelitis, and secondarily infected osseous tuberculosis. The results are extremely gratifying. The most striking case recently, was of an extensive pyogenic involvement of the carpus and metacarpals secondary to a tenosynovitis. After a course of several months of the old treatment with small incisions, daily dressings, and posterior splint support had brought the hand to the point where amputation seemed inevitable, institution of the present treatment was followed by a surprisingly rapid and almost complete recovery. Our soft tissue infections are similarly treated and results have been as happy.

(Signed)
J. E. Milgram.

The introduction of a new surgical technic is always enhanced by a clear-cut series of exhibits. Those which appear in this chapter have been chosen to illustrate not only the successes of the Orr method in the hands of other surgeons, but also to display the various phases of the method and the problems which arise as cases vary. It should be apparent from these cases, if not from the explanation in the previous chapters, just how the method is meant to be applied and what results are to be expected.

These pages, taken as a whole, present an interesting study in one rather limited field in the whole realm of operative surgery. The treatment of osteomyelitis and of compound fractures is, after all, only a part of the task of even such a specialist as an orthopedic surgeon. Limited as this specialization may be, however, it has problems that are akin to the problems of all other fields of surgery, and the discussion of a new procedure in this will have its bearing on other fields. It is difficult in this era of highly specialized treatment to lift one's head high enough to see over the walls that mark off the particular plot we have chosen to cultivate; when the occasion requires it, however, we must make the effort in the interests of progress in general.

Such an occasion is this. The surgical principles upon which so much has been said in these pages are sound in other fields besides those of fractures and osteomyelitis. And if they are sound elsewhere, it is conceivable that insistence on them is as necessary elsewhere as we have found it here. The abuses of Listerism, likewise, are not limited to orthopedic surgery; we must spread the doctrine elsewhere that antiseptics can aid in creating favorable conditions for healing, but that they often prove detrimental when used as combat troops for daily warfare with infection in a wound. It is possible that modifications of other surgical dogmas or actual reforms in other fields of surgery may be suggested by what has been described in these pages. As an illustration it may be mentioned that this method has been employed with great success in mastoid operations. It has been found possible to allow the primary dressing of a mastoid operation to remain in place until healing is well established or almost complete. To avoid the daily torture of mastoid dressings in small children is in itself a contribution of some importance. A method, therefore, leading to a higher percentage of cures or an equal number of better cures, to fewer operations, to less suffering on the part of patients, to less expensive treatment, and to other such results may well commend itself as an example whereby the specialists in other branches of the surgical sciences may test their results. And if the satisfaction afforded by the experiences and results recorded here is any test of what others may find, no other reward need be offered.

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